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ANNUAL REPORT

OF THE

GOVERNMENT EXPERIMENTAL FARM,

POONA,

For the year ending 31st March 1895.

Office of the Survey Commissioner and Director, Land Records and Agriculture, Bombay.

No. $\frac{A}{1003}$ or 1895.

The accompanying Report on the working of the Government Experimental Farm, Poona, for 1894-95, is published for general information and for distribution to Government officers and public bodies according to the sanctioned list.

C. W. GODFREY, Colonel,
Acting Survey Commissioner
and Director, Land Records and Agriculture.

Dated Poona, 8th July 1895.

ANNUAL REPORT OF THE GOVERNMENT EXPERIMENTAL FARM, POONA, FOR THE YEAR ENDING 31ST MARCH 1895.

No. 236 OF 1895.

From

J. W. MOLLISON, ESQUIRE, M.R.A.C.,
Superintendent of Farms, Bombay Presidency;

To

COLONEL C. W. GODFREY,
Acting Survey Commissioner and Director,
Land Records and Agriculture, Bombay.

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Kirkee, 6th July 1895.

SIR,

I have the honour to submit the Annual Report of the Poona Farm for the year 1894-95.

SEASON.

2. The character of the season was somewhat unusual. The total rainfall was nearly average, but was not well distributed. Very little rain fell before July. In that month the fall was abnormally heavy. Sowing operations, which began late, were much interrupted, and in the Poona district the earliest sown crops were damaged to the extent that they had to be re-sown. Throughout the Deccan, and especially in the districts where cotton is the staple crop, the season was distinctly unfavourable. During August and September the rainfall was light, and crops generally suffered owing to the long breaks between showers. In October there was heavy rain when it was not wanted. The rainfall at the end of the month damaged, to a very serious extent, crops which were cut and lying in the fields or were ripe for harvest. The grain sprouted in the ears. Bájri in the Deccan and rice in the Konkan suffered most in this respect. There was no grazing until late in July, and for several months before this the rates for cattle food and fodder were very high. The season for grazing was very short on grass land which we rented. No rain fell in November or December, and on dry-crop land rabi crops were poor. This did not materially affect the crops on the farm, canal water being available to help late sown crops. Imported English potatoes, owing to the heavy July rain, rotted in part before they germinated. Bájri was damaged by the October rain, but other crops did not suffer much, chiefly because a considerable area was under fodder crops which were in part ready for reaping earlier. Some of the fodder crops got over-ripe because they could not be reaped during the continuous rain of this month. The heavy rain helped the grass left for hay on the Mánjri stock farm and a very good crop was obtained. On the whole, the season for the farm was favourable.

3. The following table compares the rainfall of the season with that of 1893 and with the average of the preceding nine years:—

Rainfall Return.

Months.	1893.		1894.		Average of nine years (1885 to 1893)
	Rainy days.	Rainfall in inches.	Rainy days.	Rainfall in inches.	
May, 1st fortnight ...	...	...	...	...	1·98
Do. 2nd do. ...	5	3·36	1	0·22	
June, 1st do. ...	7	2·26	7	2·02	5·86
Do. 2nd do. ...	12	12·27	4	0·94	
July, 1st do. ...	8	1·31	9	7·97	8·10
Do. 2nd do. ...	10	1·02	7	7·35	
August, 1st do. ...	12	3·67	3	1·10	3·04
Do. 2nd do. ...	8	0·52	3	1·66	
September, 1st do. ...	11	0·71	4	1·65	6·36
Do. 2nd do. ...	5	1·24	4	1·60	
October, 1st do. ...	5	3·41	3	4·07	6·12
Do. 2nd do. ...	...	...	7	3·86	
November, 1st do. ...	3	0·51	...	...	1·86
Do. 2nd do. ...	2	0·52	...	...	
December, 1st do. ...	...	...	...	...	0·45
Do. 2nd do. ...	...	...	...	...	
Total ...	88	30·80	52	32·44	33·77

4. The following table shows the areas under different crops during the year under report :—

Statement showing the Area under Cultivation, 1894-95.

Crops.	Area.		Remarks.
	A.	g.	
Bájri and Bájro	4	29	*Note.*—Of the total, 13 acres 29 gunthas were twice cropped and 5 acres were thrice cropped; whilst 7 acres 25 gunthas were under perennial crops.
American sorghum ...	0	15	
Potatoes	5	22	
Gram	5	17	
Ginger	0	10	
Turmeric	0	12	
Vegetables	0	28	
Guinea grass, &c. ...	7	25	
Lucerne	0	5	
Various fodders	34	21	
Total ...	59	24	

The above statement does not include about four acres under fodder crops and onions which were not ripe at the end of the year under report. It will be observed that part of the land was thrice cropped during the year. This can be managed, because we have a large supply of cattle manure, and a larger area would have been so treated if a better supply of canal water could have been obtained in the hot weather.

Experiments.

5. The farm affords no great scope for comparative manure and other experiments on account of the uneven character of the soil. It is chiefly utilized to grow fodder crops for the dairy cattle. The improvement of the fodder supply in the Deccan is of very great importance. I think we will be able in time to estimate correctly the value of local varieties for fodder in comparison with varieties introduced from other districts and from abroad. The varying character of the soil on the farm will help the issue, in as much as trials can be made under a variety of conditions. There is good hope of supplanting inferior varieties by good varieties, the latter being introduced from other districts. There are very great differences in the quality of both the grain and fodder of the same crop in different districts of the Bombay Presidency. This may in part be due to natural conditions over which the cultivator has no control, but is not entirely so. I have made an effort to get this year for trial as many varieties of Jowári(Sorghum vulgare) as possible. It is the most important grain and fodder crop we have. I have obtained in the Presidency more than sixty kinds, and the difference in the appearance and quality of the grain from different districts is most remarkable. Each sample of seed has been sown, half for a seed crop and half for a fodder crop, my object being to select from the ripe crops the best heads from the best grain varieties and from the best fodder varieties. The seed obtained in this manner will be of undoubted purity. The best fodder varieties are intended for continued cultivation on the Poona farm, the best grain varieties for the Surat farm, where, when started next year, the improvement of seed by selection will be made a speciality. In addition to the fodder question, the Poona farm is utilized to study and improve the milch breeds of India, to test native practices, to test exotic crops, and crops of other districts not known in the Deccan. The comparative value of leguminous fodder crops suitable for rotation with cereal fodder crops has been under trial for some years. A little has been done in the improvement of seed by selection and in the distribution of seed, also in comparing manures and in trying implements. The selection and improvement of seed and comparative experiments with manures have not been attempted to any extent at Poona because there is no scope for doing so. The land selected for the Surat farm is much more suitable for comparative experiments, and this work will be started there in a systematic manner next year.

The farm unsuitable for comparative experiments, but can be usefully employed otherwise.

Selection of seed.

The objects aimed at on the farm.

Fodder Experiments.

6. The results of trials in former years proved that some of the sorghums generally cultivated are, when sown thickly, exceptionally good fodder crops. I referred last year to the superiority of Sundhia Jowári, a distinct variety of sorghum (cernuus) introduced from Gujarát. Its superiority depends upon its yielding heavily and at the same time in producing long thin stalks which can be fed with little or no wastage. A considerable quantity of seed was supplied last year to the Superintendent of the Remount Depôt farm, Ahmadnagar, and he was so satisfied with the results, that I obtained for him this year 5,000 lbs. of seed (enough to sow 100 acres). There were a number of other applications for small parcels of seed.

Sundhia Jowári, Imphee, Nilva Jowári, American Sugar Sorghum, Reana luxurians.

7. Sundhia Jowári was compared with Nilva Jowári (the best local variety), American sugar sorghum (Sorghum saccharatum), Imphee or African sugarcane (Sorghum saccharatum), and Teosente (Reana luxurians). The plots were $\frac{1}{5}$ acre each and fairly even. The area was double cropped in the previous year by a cereal in the kharif season and by a well manured potato crop in the rabi season. No manure was given in the year under report, the field being in good condition. The crops on these plots were, like most of the other rain-crop fodders on the farm, sown late in July and were sufficiently matured to be harvested early in October. Rain fell more or less during the whole month. There was abundant grazing at this time and there was no need of other green fodder for the dairy cattle; consequently it was decided to cure the fodder into *kadbi*, although, if the unusual character of the season had been anticipated, the decision would have been otherwise. The rain was so heavy and so incessant that the crops were lodged and harvest belated. During breaks in the rain efforts were made to harvest the fodder crops before they became over-ripe. This was only partially successful. The Dutch barn on the farm proved specially valuable. The half dried *kadbi* was carried to the Dutch barn and stored there whilst rain threatened and was brought out to dry in fair weather. Under the circumstances it was impossible to prevent the mixing of the crops of different plots and different fields, and the outturn results which I report are only approximately accurate. The bundles or sheaves from each plot or field were counted. Twenty bundles from each plot or field were selected as average and kept separate until sufficiently dry for safe storage. The outturn results are based on the dry weight of these bundles and on the supposition that average bundles were selected. I am almost certain that the bundles selected were as near as possible average; and although the outturn figures are in round numbers, they may be accepted as approximately accurate without any hesitation.

8. I tabulate below the results of the comparative fodder plots giving seed rates and the yields per acre, the cost of cultivation, and the value of outturns:—

Crop.	Seed rate per Acre.	Outturn per Acre. (Dry fodder)	Cost of cultivation per Acre.	Value of outturn per Acre.	Rate per Rupee.	Remarks.
	Lbs.	Lbs.	Rs. a. p.	Rs. a. p.	Lbs.	
Sundhia Jowári—(Sorghum cernuus).	75	8,960	15 13 4	68 14 0	130	Crop sown on 29th July. Reaped while in full flower on 7th October. The crop suffered more than the other comparative crops during the dry weather of August and September. The seed rate being high, the produce was of exceptionally good quality, the stalks being very fine. The green fodder gave 49 per cent of dry fodder after drying 15 days.

Crop.	Seed rate per Acre.	Outturn per Acre. (Dry fodder)	Cost of cultivation per Acre.	Value of outturn per Acre.	Rate per Rupee.	Remarks.
	Lbs.	Lbs.	Rs. a. p.	Rs. a. p.	Lbs.	
Imphee—African sugarcane— (Sorghum saccharatum.)	75	11,220	19 10 7	74 12 0	150	Sown on 29th July. Reaped when in full flower on 7th October. The stalks were not so thin as those of Sundhia. The fodder was of fine quality. Imphee is apparently very succulent in the green state. The green fodder gave 37 per cent of dry fodder after drying 15 days.
Nilva Jowári— (Sorghum vulgare.)	65	18,200	17 13 0	113 12 0	160	Sown on 29th July. Reaped on 5th November. It was ripe for fodder in the third week of October, but owing to the continuous rain harvest was delayed three weeks. Meantime the crop lodged and got over-ripe for the best quality of fodder.
American Sugar Sorghum— (Sorghum saccharatum.)	70	19,200	17 7 0	120 0 0	160	Do. do. do.
Teosente— (Reana luxuriens.)	20	6,690	17 14 0	37 2 0	180	Sown on 29th July. Reaped on 5th November. The fodder was very coarse, yet the crop was not over-ripe for fodder. Germination was uneven and the crop made very slow progress during the dry weather of August-September. It improved during the rains of October. It evidently requires a regular rainfall to keep it thriving.

Analysis of the above tabulated results.

9. The results reported above are to some extent unsatisfactory, because owing to the character of the season they are not strictly comparable. General deductions can be drawn which are of importance. We may conclude that Sundhia Jowári, although it yielded a finer description of fodder than any of the varieties tested, suffered more from drought than the Nilva or the American sugar sorghum or Imphee. I have in a former report noted that it is more subject to rust and to be lodged by rain than the local varieties. Although the Sundhia results were somewhat disappointing this year, there is no doubt it is one of the best fodder crops that can be grown on good land in good condition in a year of good well distributed rainfall. The American sugar sorghum yielded uncommonly well, and its feeding value cannot be doubted, as the stalks when nearly ripe contain about 10 per cent sugar. Like Imphee (which is also rich in sugar) it is very succulent if cut at the flowering stage. Sundhia Jowári and Nilva are much less so. The Imphee results are considerably better than those I reported last year. It was then grown as a hot weather irrigated crop. The inference is that it does best in the Deccan as a kharif rain crop. It, like

Sundhia, matures very quickly. Teosente (Reana luxurians) is an introduction from South Africa. Its value as a useful fodder plant may be discounted. It yields well in a season of good rainfall. The field must be in good condition for Teosente. The seed should be dibbled at the rate of 2 to 4 lbs. per acre. If drilled, more seed must necessarily be sown, and the seedlings require to be thinned out to a foot or fifteen inches apart. The crop tillers freely, is exhaustive, and produces in a favourable year a great weight of fodder, which is however coarse, the stalks being very thick and woody.

Some fodders more succulent than others. The dry weight the correct basis for comparison.

10. In my last report I compared fodders according to their green weight. There is a wide range in the percentages of water found in various fodders in their green state, and the dry weight is the correct basis for comparison. This standard will be adopted henceforth, or at any rate the loss by dryage will be determined. This year in the comparative plots we were only able to compare the green and dry weights of Imphee and Sundhia, the other crops being over-ripe when harvested.

Thick and thin seeding for fodder crops compared.

11. In my last report I showed by actual figures the importance of sowing sorghum fodder crops thickly. I pointed out that thick seeding increased the outturn and improved the quality of the fodder by making the stalks thinner. Again this year we had comparative plots to test the best seed rates for the Nilva and Sundhia varieties of Jowári. During the dry weather of August-September it became clear that the plots were uneven. The lighter soil of the field suffered most. I do not report the figures, because they are unreliable. But I concluded from the appearance of the crops of the farm this year and during the previous two years that thick seeding succeeds best on deep black soil in good manurial condition with average well distributed rainfall. It does very well on light land if the rainfall is sufficient and the land in good condition. If the rainfall is deficient or if the crop passes through a period of drought, a thinner rate of seeding would give probably better results on good deep soil and certainly better results on thin red soil. On the latter description of soil, a thickly sown crop withers much sooner than a thin sown crop during prolonged periods of dry weather. Comparative tests are being again made this year on light soil and on deep black soil.

Nilva Jowári and Sundhia Jowári compared as rain crops.

12. The average outturn &c. results from all the fields on the farm of Nilva Jowári and Sundhia Jowári are as under. The results are from rain crops only, and the weight of outturn is for dry fodder :—

Crop.	Seed rate per Acre.	Outturn per Acre (Dry fodder)	Cost of cultivation per Acre.	Value of outturn per Acre.	Rate per Rupee.	Remarks.
	Lbs.	Lbs.	Rs. a. p.	Rs. a. p.	Lbs.	
Nilva Jowári (Sorghum vulgare).	54	6,604	26. 10 0	44 0 0	150	
Sundhia Jowári (Sorghum cernuus).	33	5,005	24 1 0	38 8 0	130	Valued at a higher rate on account of its better quality.

13. In last year's report a similar comparison was made of these fodders. Last year the outturn weights were those of green fodder. This year's results are not comparable with last year's for other reasons also ; but the results of both years tend to show that on the good land and the inferior land of the farm, if taken together, there is little to choose between the two varieties. If the farm consisted entirely of good deep land, the Sundhia would, I feel sure, give the best results. Both these varieties succeed only moderately well as cold or hot weather irrigated crops in the Deccan. In Gujarát, Sundhia is extensively cultivated in

the hot weather to supply fodder in May and June when other fodder is scant and dear.

Nilva and Sundhia as hot weather irrigated crops.

14. The following results were obtained from Nilva and Sundhia sown side by side on a comparatively even field. Seed was sown on the 13th March 1894. The Sundhia was ready much the soonest, being reaped for fodder between the 21st and 25th May 1894, whilst the Nilva was harvested for fodder between the 30th June and 18th July :—

Crop.	Outturn per Acre (Dry fodder).	Cost of cultivation per Acre.	Value of outturn per Acre.	Rate per Rupee.	Remarks.
	Lbs.	Rs. a. p.	Rs. a. p.	Lbs.	
Nilva	6,369	36 5 0	42 7 0	150	The Nilva was watered oftener than the Sundhia, hence the extra cost of cultivation.
Sundhia	4,411	30 8 0	33 15 0	130	

Hundi Jowári.

15. The above results are poor considering that the crops were regularly irrigated. I think it is probable that Hundi, a Deccan variety of Jowári, which is now under trial, will be found to do better as a hot weather crop than either Nilva or Sundhia.

16. *Guinea Grass* (Panicum jumentorum).—The results this year are much the same as they were last. In both years they were unfavourably affected by a short and irregular supply of water from the canal, especially in the hot weather. At this season Guinea grass requires a full flooding at least every eight days, whereas we cannot get water oftener than once a fortnight. Although Guinea grass has no dead season, it grows with far more vigour during the rains than at any other season. In the year under report the rains came late and the Guinea grass did not recover the check of the hot weather until July-August. Then the outturn at each cutting was more than double what it was in the hot weather. A considerable portion of the farm crop has been purposely planted along borders under fruit trees, also on lands adjoining the irrigation channels, where the soil is often too wet for other crops and in other situations where other crops would not thrive. One of the chief advantages of the crop is that it thrives well in such situations. During the hot weather it was observable that the crop produced much more under shade than it did in the open. It is not likely that this would have been the case if there had been a full supply of water for irrigation.

Guinea grass grown under conditions unfavourable to other crops.

17. I think I may state definitely that it will pay to re-plant Guinea grass when the plantation is established about three years. If the crop was originally planted in regular rows it is unnecessary to change the area. Sets chopped off from the old stumps which occupy the ridges may be planted at the correct distance apart in the furrows ; and when the new sets are fully established, the old root stocks may be removed. When this is done the new sets should be earthed up and then they occupy the ridges. Furrows for the irrigation water are thus formed, one between every two rows. If this method of plantation is adopted, the old root stocks will yield some produce whilst the young plantation is becoming established.

Replantation of Guinea grass necessary after three years.

18. The results for 1893-94 and for 1894-95 from fully established plantations are tabulated below for comparison. This cannot be accepted as indicating the capabilities of the crop when grown under more favourable conditions. The produce is valued at 200 lbs. per rupee, the rate at which it is charged to the dairy cattle :—

Guinea grass outturn results unfavourably affected.

Year.	Rate per Rupee.	Outturn per Acre.	Value of outturn per Acre.	Cost of cultivation per Acre.	Remarks.
	Lbs.	Lbs.	Rs. a. p.	Rs. a. p.	
1893-94 ...	200	21,295	106 7 0	81 11 0	Three fields cut ten times and two nine times.
1894-95 ...	200	21,112	105 9 0	45 10 0	The cost of cultivation is less in 1894-95 owing to lighter applications of manure. Four fields cut seven times and two six times.

19. *Mauritius Water Grass.*—This grass was obtained from Ceylon, where it supplies the chief fodder for milch and other cattle. As its name implies it likes a low-lying damp situation. It is sometimes called Buffalo grass. The farm plot is situate under one of the distributing water channels. The soil is continuously moist, sometimes wet. No other cultivated crop would thrive in the same situation. The plot is only one-tenth of an acre, but it is well enough established now to afford cuttings for planting out a large area. The only other suitable area on the farm is at present under ordinary grass. I intend to break up a portion of this land in the current season and plant it out with water grass. The method of propagation is very simple. The stalks are cut into lengths, each length having two or three nodes. Broadcast these sparingly and cover lightly with soil. The stems root at every node and as the plant grows the lateral stems root down to the soil at the nodes. From the nodes straight stems shoot up. The grass grows very thick on the ground, and when ready to cut stands 18 inches to 2 feet high. Cattle like it. The plot on the farm yielded four cuts, the outturn being as under :—

A good crop for low-lying wet situations.

Plot.	Yield per Plot. (Green fodder.)	Yield per Acre. (Green fodder.)
Acre.	Lbs.	Lbs.
$\frac{1}{10}$	5,002	50,020

20. *Flat Pea* (Lathyrus Sylvestris).—The unfavourable opinion given in former reports as to the utility in the Deccan of the "Great Fodder Plant" must be reiterated. The plants gradually died out on the plot of the farm until only a scattered plant here and there remained. When established about two years and a half I had the few remaining plants grubbed up. They only cumbered the ground, for they yielded absolutely nothing of any value as fodder. A large quantity of seed was sold in India at exorbitant rates by the accredited agent of the grower, chiefly through advertisement and laudatory notices in the Press. The agent at one time published his intention of starting a "Great Fodder Plant" farm in the Deccan, but evidently wiser counsel has prevailed since.

A complete failure.

21. Mr. Keventer, the dairy expert, supplied me with some Egyptian clover seed which he brought from Egypt. The trial was practically a failure. The seed germinated all right, but the seedlings made no progress. They grew into dwarfed plants just like the vetches, sainfoin, and other leguminous crops of England tried on the Poona farm several years ago. It is useless persevering with an exotic fodder crop which does not under fair trial succeed at once, because in India we have a large number of really good indigenous fodder plants both cereal and leguminous to select from.

Egyptian Clover.

Failed.

22. Good rotation is as necessary in growing fodder crops as in ordinary cultivation. The sorghums and millets yield heavily, but they will not thrive unless they are regularly alternated with a good rotation crop. In the light of very ancient practice both

Value of good rotation.

in India and elsewhere, and in the light of recent scientific investigation, leguminous plants of the papilionaceous sub-order are the best crops to rotate with cereals, because, to put it briefly, they enrich the soil with nitrogen which becomes available as plant food. The number of leguminous crops cultivated in India which can be referred to the papilionaceæ is most remarkable. The growth of these crops in rotation with cereals or as mixed crops has probably done more to maintain the fertility of the Indian soils than any other cause. It is by no means difficult to select from these crops, several of which are suitable as fodder in their green state and are at the same time useful for rotation. We are chiefly interested in testing such leguminous crops as in their green state are good for milch cattle. Chola (Dolichos catiang) and Vál (Dolichos lablab) each give promising results. Both do well in the rains on any kind of soil with sufficient rainfall, but best on good deep soil. Each crop if it grows well forms a thick matted mass of vegetation which completely shades the ground and smothers all surface weeds. This is a point of special value, for, the succeeding crop requires much less weeding. Vál does well in the cold weather without irrigation on deep black soil if the late rains are favourable, and does exceptionally well under irrigation at this season. Chola, on the other hand, does not. Our results indicate that Chola is better than Vál as a rain crop on any kind of soil. Vál is the best in the cold weather with or without irrigation. At this season this year Chola practically failed, whilst last year an irrigated crop in the hot weather gave 50 per cent more produce than Vál (see Report for 1893-94). Both these fodders in their green state are greedily eaten with little or no waste by milch cattle.

Chola (Dolichos catiang), Vál (Dolichos lablab), both good fodder and rotation crops.

23. The following tabulated figures show the rain crop results. The estimated value is the rate at which the fodder was charged to the dairy cattle :—

Crop.	Seed rate per Acre.	Outturn per Acre.	Cost of cultivation per Acre.	Value of outturn per Acre.	Rate per Rupee.	Remarks.
	Lbs.	Lbs.	Rs. a.	Rs. a.	Lbs.	
Chola	40	12,089	16 14	48 5	250	Figures not intended for critical comparison.
Vál	47	7,998	19 6	32 0	250	Crops grown side by side in some fields, but soil uneven.

24. *Lucerne* (Medicago sativa).—This excellent fodder crop is so susceptible of damage by disease and other mishaps in the Poona district that the area cropped with it is getting less and less every year. We have made efforts to combat the damage done by fungoid disease and insect pests, but so far with very little success. The fungoid disease attacks the roots, and light dressing of copper sulphate applied to the soil during rain has no effect in checking it, and the insects swarm to the extent that they are very difficult to deal with. I have noticed in former reports that if lucerne is grown as a mixed crop, it remains longer healthy than if grown alone. This fact was illustrated in several lucerne plots which had become patchy through disease and were filled up with Guinea grass-sets. The lucerne revived in a remarkable manner, and the mixed crops have done very well. I have sown lucerne again with the object of testing definitely the comparative value of lucerne and Guinea grass as compared with lucerne alone. The experiment has not yet advanced sufficiently to report results. If we can prove any advantage, the cultivation of Guinea grass as well as lucerne will extend particularly in the vicinity of military cantonments. It is certain that Guinea grass is nearly as good a food for horses in hard condition as lucerne is, and it is probable that a half-and-half mixture of lucerne and Guinea grass would be superior to either alone.

The common fungoid disease not amenable to treatment.

Probable advantage of growing Lucerne and Guinea grass as a mixed crop.

25. *American Sugar Sorghums.*—In the appended note of sugarcane experiments at Mánjri, I have explained that the American sugar sorghum will not likely prove a useful sugar crop for the Deccan or for any part of India. We have had two varieties under trial—Amber and Collier. There is little to choose between them either as to the percentage of sugar they contain or as fodder crops. As fodder rain crops they have each exceptional merit, but if sown in the cold weather neither of them succeeds. Nature asserts her sway in an extraordinary manner. In the year under report we sowed sorghum for a cold weather irrigated crop. It was clear that only a portion of the seed germinated. Many of the seedlings soon died off, the others made no progress. The field was several times irrigated. The small amount of produce was reaped, the land ploughed up and harrowed. It was left in this condition until the first rains of the current season, when the seed left in the ground germinated, and soon the seedlings in rows could easily be seen. The same thing occurred with Teosente (Reana luxurians), another exotic crop, the seed in each case being the produce of the rain crop reaped about a month before. Even in the case of indigenous crops *new* seed does not germinate well.

Two American varieties of Sorghum saccharatum, "Amber" and "Collier."

26. We sowed as rain crops the two varieties of sorghum. The chief object was to get seed. A portion, however, of each crop was cut earlier for *Gul* making. Apparently the sorghums contain the greatest amount of sugar in the stalks when the flowering stage has passed and the seeds have not yet formed to any extent. If there was any hope of the sorghums proving useful as sugar crops, this point would be thoroughly investigated.

27. The sugar results from the two varieties were as under, the product being molasses :—

Variety of Sorghum.	Weight of Molasses per Acre.	Value of Molasses per Acre.
	Lbs.	Rs. a.
Collier	1,174	36 11
Amber	1,072	33 8

28. In comparison with the above, I show below the combined values of the two varieties for seed and fodder. The fodder being dead ripe is valued at the cheap rate of 300 lbs. per rupee. I regret that the fodders of the two varieties were not separately weighed :

	Dry fodder per Acre.	Seed per Acre.	Value of outturn per Acre.
	Lbs.	Lbs.	Rs. a.
Collier and Amber ...	12,457	457	55 13

29. The seed of each variety is large and plump, and should, as food grain, command an equal market rate with the red and yellow varieties of Jowári so largely grown in the Southern Mahratta Country. The sorghums have a decided advantage as grain crops, because the grain head takes the form of a graceful drooping panicle on which birds can obtain no foothold. The crop requires no watching if there are fields of Jowári or Bájri in the vicinity.

Sorghum seed probably a useful food grain.

Experiments with Grain Crops.

30. *Bájro* and *Bájri* (Pennisetum typhoideum).—The giant Bájro of Gujarát was again compared with the *deshi* variety of Bájri. The crops were grown side by side on land which had previously grown potatoes. The soil was in exceptionally good condition. Each crop was grown from selected seed, *i. e.* from the seed of the largest and best filled

The giant Bájro of Gujarát compared with the indigenous Bájri of the Deccan.

ears of the comparative crops of the previous year. The results this year would have been exceptionally good if the crops had not been more or less damaged when ripe by heavy rain. Each crop was badly lodged and harvest was delayed after ripening. The grain sprouted in a good many ears lying against the ground. I compare in the following table the results of this year and last. I do not compare cost of cultivation in each year, because extra expenses were incurred this year to prevent damage by birds whilst harvest was delayed. Each plot was only nine gunthás. There was no other crop near which it was necessary to watch, therefore the per acre rate of watching works out high.

Crop.	Outturn per Acre, 1893-94.		Outturn per Acre, 1894-95.	
	Grain.	Straw.	Grain.	Straw.
	Lbs.	Lbs.	Lbs.	Lbs.
Bájro	1,080	5,250	1,738	6,666
Bájri	820	4,812	1,031	6,133

31. In each year Bájro has shown a decided advantage over Bájri. I am hopeful that the distribution of Bájro seed which has been made to selected cultivators of the Poona district will be permanently beneficial if the cultivators will keep the seed pure. I do not think, however, that the Bájro would prove itself superior to Bájri unless the land on which it is grown is good deep soil in fair condition. The selection of seed from each variety will be continued year by year, and in time we may get the indigenous variety up to a higher standard, at the same time the Bájro may also improve. There are very few varieties of Bájri known in the Presidency. I know of only one other besides those referred to above. It is a superior variety, the cultivation of which is almost confined to Boriavi, a village of the Kaira district noted for its good cultivation. The spikes of grain are much larger and better filled than in the *deshi* variety of Gujarát. The grain is also larger, and considering that its cultivation is limited to a small area I have no doubt it was recently obtained by selection and possibly from a single plant. I have obtained seed which I believe to be pure and will test it in the current year alongside Bájro and the Bájri of the Deccan, on light soil as well as on deep mixed black soil.

Bájro seed distributed to cultivators.

Continuance of selection and pedigreeing of Bájro and Bajri seed.

Another superior variety of Bajri.

32. *Tur* (Cajanus indicus).—White Tur, which is extensively grown throughout Gujarát, was compared with the red-seeded variety, which is the only sort known in the Deccan. Each variety was sown as a mixed crop with Bájro. The Tur occupied every fourth row. Both varieties branched out well after the Bájro was reaped in October, but the red Tur was more uneven than the white. Each variety was ripe about the same time. Irrespective of the Bájro produce, each variety yielded as under :—

White and red Tur (Cajanus indicus) compared.

	Outturn of Pulse per acre, lbs.
White Tur	540
Red Tur	328

The respective merits of the two varieties are not fairly gauged by the above figures. The trial is being continued in the current season, and I think that it will be found that the white Tur has not the advantage over the red indicated above. The pulse of the white Tur is however undoubtedly the best in quality.

33. *Gram* (Cicer arietinum).—The common practice of nipping off the leading shoots of the gram in order to encourage branching and the formation of more flowers and fruit was again tested this year against non-pruning. The pruning costs nothing, because the farm servants

The outturn from pruned or nipped gram compared with that of non-pruned gram.

will do the work in their own time, if they are allowed to take the shoots which are removed. Care must be taken that the plants are not cropped too much. The tender shoots when sun-dried are stored and can be used at any time as a delicate vegetable. The results of this year and last are tabulated below for comparison. In both years the crops were irrigated. Some of the pods did not fill this year owing to cloudy weather at flowering time, otherwise the crop was exceptionally good.

Plot.	Outturn of Pulse per Acre, 1893-94.	Outturn of Pulse per Acre, 1894-95.
	Lbs.	Lbs.
The nipped plot	1,375	1,325
The unnipped plot	1,090	1,071

This year the test was taken on double plots selected in two fields.

Experiments with other Crops.

Garden crops grown annually.

34. *Brinjals* (Solanum melongena).—One or two market garden crops are grown on the farm every year chiefly with the object of getting reliable information as to outturn results, and for purposes of demonstration to the agricultural students attending the College of Science. Brinjals occupied ½ acre and the area was divided into three plots. The variety grown was the large long purple sort. The seedlings were raised in a seed-bed and transplanted into hills 3 feet apart in each direction.

Comparative manure experiments.

The plots were manured respectively with fish manure, dissolved bones, and castor cake, part in each case being given before plantation and part as a top dressing. Saltpetre was subsequently applied as a top dressing to the half of each plot, and its effect was seen to be remarkable. It is probable that the potash of the nitre was the most effective ingredient because we know that potash manures are specially useful for potatoes and tobacco, both near relatives of the brinjal. The results were as under :—

Saltpetre (nitre) as manure gave remarkable results. The probable reason explained.

Kind of Manure.	Quantity of manure per Acre.	Outturn per Acre.	Cost of cultivation per Acre.	Value of outturn per Acre.	Remarks.
	Lbs.	Lbs.	Rs. a.	Rs. a.	
Fish	1,451	16,322	138 6	325 5	Comparable.
Nitre	433				
Fish	1,451	11,400	79 9	227 3	
Dissolved bones ...	1,651	11,700	224 11	233 2	Do.
Nitre	433				
Dissolved bones ...	1,651	7,882	165 2	157 2	
Castor cake	1,488	15,080	182 11	300 10	Do.
Nitre	544				
Castor cake	1,488	7,546	81 14	150 7	

The effects of the different manures analysed.

35. The variation in cost of cultivation between plots is almost entirely due to difference in value of manures applied. The cost was the same otherwise except for gathering the brinjals which varied with the outturn. The most effective and at the same time the most economical dressing is fish with a fair application of nitre. The nitre is exceedingly dear in Poona, yet in this case it

paid well to use it. The inference is that where crude nitre is cheap it could with every advantage be used for this crop. Nitre with dissolved bones gave a slight profit; dissolved bones alone a loss. Dissolved bones did not pay because it is now impossible to produce this manure in Poona except at a prohibitive rate. Bones owing to export demands have trebled in value in three years. Weak sulphuric acid is made locally, but it is not cheap. In fact it is almost as economical to use imported strong acid. Bones or dissolved bones will certainly not pay for any crop in the Poona district as long as other more effective manures can be obtained at their present market rate. No doubt the export of bones is a drain on the agricultural resources of the country, but under existing conditions it need not be deplored. Nitre added as a top dressing to the castor cake plot doubled the outturn. The application of nitre was greater than it was intended to give, through a misunderstanding as to the exact area of plot at time of application. Probably a lighter dressing at less cost would have been equally effective. Still an application costing about Rs. 100 per acre (at the exorbitant Poona rates) increased the value of outturn by about Rs. 150 per acre.

36. *Potatoes* (Solanum tuberosum).—This crop occupied about five acres in the kharif season. The sets planted were the first generation from imported English seed. The original stock was imported in October 1893 specially for direct distribution to cultivators. But the potatoes arrived in Bombay in such bad condition that no distribution was made. Only about one-fourth of the consignment was found to be good. The produce of the rain crop of the year under report was distributed at full market rates to cultivators in every potato-growing district in the Presidency and also in Sind. The supply available for distribution was not nearly sufficient to meet the indents. This was chiefly due to a poor crop owing to an exceptionally unfavourable season. Long before rain came, the potatoes began to sprout, and in anticipation of rain we began to plant towards the end of June. The potatoes were planted whole, because it was known that if rain did not soon come cut sets would undoubtedly shrivel up or rot, and if the rain was heavy, the cut sets would also probably rot. The rainfall of July was exceptionally heavy, and many even of the whole potatoes rotted in the ground. The crops grown in light land succeeded best. The river rose to a height seldom, if ever, reached before, and flooded a portion of a field, so that the crop there was entirely lost. There was some appearance of the Ring disease in the crop, but every precaution was taken to remove diseased plants as they were seen to wither; and moreover, when distributed to cultivators, tubers of the apparently healthy plants were carefully selected. I believe the potatoes which were distributed were mostly sound. The results have not been reported from all districts where the seed was distributed, but we have got reports from several. Sardár Bahádur Bechardás Vihárídás Desái of Nadiád reports a trial between the English varieties and the indigenous sort. In each case the English potatoes gave better results than the indigenous sort, one English variety, "Supreme," doing exceptionally well. A good report has been received from Sind. In the Poona district the cultivators who got English potatoes from the Department three years ago were keen to buy, but we had to send many away disappointed. Three or four times the quantity sold could easily have been disposed of. In the face of these facts, it might be asked why should not English potatoes be imported to a large extent for direct distribution or be grown on Government farms and the increase distributed. The answer is that cultivators could not afford to pay more than half the cost price of imported potatoes. Moreover, there is the risk of the consignment being destroyed during transit; and there is the certainty that although newly imported potatoes resist the Ring disease for a little, they succumb to it in the third or fourth generation. Our efforts towards checking this fungoid disease have already been fully reported. I regret that I cannot suggest any simple treatment beyond what has been tried already. Cop-

Risk in importing English varieties.

Distribution to cultivators.

An unfavourable season for potatoes

Favourable reports received as to success of seed distributed.

Why should not the distribution on a large scale of English potatoes be undertaken.

Efforts made to check the Indian potato disease.

per sulphate applied with the irrigation water was certainly effective to a considerable extent, but it is costly and requires careful application, and the treatment would require to be general to be effective. The disease is more rife in the Poona district than in any other part of the Presidency, the reason being that potatoes are here taken in such rapid succession on the same land, that disease germs harbouring in the soil attack each succeeding crop. The effect of the disease has been so disastrous in the Poona district that cultivators have stopped growing potatoes to a considerable extent and plant onions instead. If this practice be generally adopted, the fields will get clear in time and sound crops may probably be grown again.

Cultivators responsible for prevalence of potato disease.

A probable ameliorating influence.

37. The rain crop results on the farm were as under. The varieties were supplied by Messrs. Sutton and Sons, Reading, England :—

Variety.	Seed rate per Acre.	Outturn per Acre.	Cost of cultivation per Acre.	Value of outturn per Acre.	Remarks.
	Lbs.	Lbs.	Rs. a. p.	Rs. a. p.	
A.—Grown on light land, field not much damaged by rain—					
Windsor Castle ...	1,920	7,981	155 4 0	332 8 0	Valued at 24 lbs. per Rupee, the price at which the potatoes were sold to cultivators.
Early Regent ...	2,014	8,962	159 4 0	373 6 0	
B.—Grown on other fields considerably damaged by rain—					
Early Regent ...	1,886	3,824	137 7 0	159 5 0	Do.
Supreme	1,396	5,050	133 10 0	210 7 0	
Matchless ...	1,534	1,820	139 11 0	75 13 0	
Italian potatoes ...	2,085	2,610	162 7 0	108 12 0	

38. *Potatoes propagated from Seeds.*—I regret that the seedlings which I raised from the absolute seed four years ago and continued to propagate from the tubers since, have become affected with Ring disease, and there is now no hope of their being useful varieties.

Failure.

39. *Steeping Potatoes before Planting.*—The Commissary General, Bombay Command, requested that the effect of steeping potatoes before plantation in a solution of nitrate of potash and sulphate of ammonia might be tested. The Commissary General sent the following extract from the *Indian Agriculturist* :—

"According to the *Australian*, an enormous yield of potatoes was obtained in one of the districts of Melbourne in the following way. The farmer used sound potatoes of medium size and planted them whole, first ploughing the ground very deeply. Before planting he steeped the tubers for 24 hours in a bath composed of sulphate of ammonia and nitrate of potash of each 6 lbs. to 25 gallons of water, then allowed them to stand for 24 hours before planting. The result was that there were 30 to 40 large potatoes on each stalk and a little patch 16′ × 9′ yielded 180 lbs. net, being equal to 24 tons 6 cwt. and 18 lbs. per acre. An adjacent plot of ground was planted in the ordinary way and gave a yield of 7 tons per acre."

40. I can conceive no rational explanation why potatoes treated as above should yield better than untreated potatoes, excepting that the steeping might kill germs of disease and the nitrate of potash and sulphate of ammonia would collect more or less in the eyes of the potatoes as the solution evaporated and

when the eye-bud and rootlets began to grow would be at hand to stimulate the plant into active growth. If, however, the tubers were sprouted (as they generally are when ready to plant), it is questionable what effect a strong solution like that recommended might have on the tender shoots. It might destroy the shoots and also the germinating power of the potato. I make this observation because not a single potato germinated on the farm when treated according to the formula recommended. The tubers which were steeped were more or less sprouted. They were planted in alternate rows with untreated potatoes of the same variety. They were not planted under favourable conditions. A heavy rainfall came soon afterwards, and a good many of the unsteeped potatoes rotted in the ground.

Steeping unsuccessful in Australia and New South Wales.

41. I see from a recent report in the Agricultural Journal of New South Wales that many farmers who tried the steeping with a solution of standard strength reported complete failures; whilst an officer of the New South Wales Agricultural Department got the following results from weaker solutions and from non-treatment. In each case the same number (33) and the same weight (3 lbs.) of tubers were planted :—

	Outturn.
Half strength	22 lbs.
Quarter strength	19 „
Water only	20 „
Not treated	26 „

42. The Commissary General, Bombay Command, reports the following results at Mhow, Neemuch, and Deesa :—

Experiments undertaken by Commissariat Department only partially successful.

		Outturn from steeped seed. (Increase of seed rate.)	Outturn from untreated seed. (Increase of seed rate.)
Mhow ...	English seed ...	11·4 fold	7·5 fold
Neemuch...	English seed ...	4·3 fold.	No comparative plot.
	Country seed ...	2·65 fold	
Deesa ...	English and Simla seed.	3·97 fold	5·9 fold.

It is reported that only about half the seed germinated at Neemuch. The English seed was supplied from the produce of the rain crop of the Poona farm, and at date of plantation could not have been sprouted, or if so, only to a trifling extent.

43. A further experiment will be undertaken on the Poona farm to prove the effect on sprouted and unsprouted seed, also to test whether a solution of weaker strength gives better results than one of standard strength.

The cultivation of ginger and turmeric not successful.

44. Small areas of ginger (Zingiber officinalis) and turmeric (Curcuma longa) were grown. The season was unfavourable. Poor results were got from each. The turmeric is again being grown with the object of getting accurate outturn figures of a good crop.

Cotton.

Improvement of indigenous varieties.

45. In my report of 1893-94, I detailed at considerable length the plan of experiment formulated for the improvement of indigenous varieties of cotton at a Conference held in 1891 under the orders of Government. The Conference proposed as one line of experiment that the truly wild forms of cotton from which the improved cottons originally sprung "should be cultivated "over a series of years in localities apart from each other and in proximity and "apart from and in proximity to cultivated cottons. The object of the expe- "riment should be to ascertain whether the wild plants can be improved by "any system of cultivation and whether under cultivation they show any "tendency to produce valuable sprouts which by seminal cultivation can be "perpetuated or whether by hybridization between these species and between them

"and cultivated cottons, a superior quality of hybrid cotton could be produced "which would be fairly fixed or less liable to degeneration than some of the "cottons presently grown."

Wild cottons of India.

46. We have had three wild forms (Gossypium Stocksii from Sind, G. arboreum from the Punjáb, and G. Wightianum from Western Rájputána) under cultivation for two years. We got seed of a fourth wild form recently found by Dr. Watt in Káthiáwár, but none of the seed germinated. The wild forms are under cultivation strictly in accordance with the above scheme. But there is nothing to report of practical value. The seed produce in the first year (except that of G. arboreum) failed to germinate. Each wild form fruits and flowers freely. But I do not see that the lint is any better than that produced when the plants grow in their wild state. The behaviour of wild cotton plants under cultivation provides no doubt an interesting botanical study. But if the chief object is to improve existing staples, there is little doubt that much more progress can be made by selection of seed and the careful cultivation of our best commercial varieties.

The improvement of cotton on practical lines.

The improvement of local varieties of cotton to be started systematically at the Surat farm.

47. The Surat farm when it is started next year will afford scope, in an important cotton district, for taking up the question of cotton improvement in a systematic manner. We may accept the fact from previous experience that it is a mistake to meddle much with any variety indigenous to a district. The only hope of improvement appears to be in the selection of seed and in the distribution of seed of the best local variety, the best local variety in Broach and Surat being that which the cultivators find pays them best.

Surat cotton practically pure.

The cultivators differentiate between varieties which botanically are practically identical.

48. The cotton in Surat is to all intents and purposes *pure*. In the vicinity of Surat, Dr. Watt, though he walked through miles of cotton, could not find a single plant differing from the recognised type. We know that cultivators in the Surat Collectorate recognize several varieties which Dr. Watt determined were closely related botanically to the *deshi* variety or almost identical.

Lália cotton, probably one of the best cottons of India.

A variety called *Lália* is cultivated to a considerable extent at Navsarí (Baroda), and doubtless its cultivation will extend because the cultivators find it pays them well to grow it, and cotton buyers are keen to get it because the staple is long and fine. It is probably one of the best cottons in cultivation in India. With the object of having pure seed for making a beginning at Surat next year,

Efforts to select and pedigree cotton seed.

I obtained last year a small quantity of seed by selecting the biggest bolls from the most vigorous growing plants in a good field. This has been grown one year at the Poona farm, and alongside the *Lália* I sowed seed of the *deshi* variety of Surat obtained by picking the best bolls from a single plant, the plant being selected on account of its size, its branching habit of growth, and the numerous bolls it carried. According to my judgment, the lint was of fine quality. I also selected from a number of plants the best bolls I could find, always choosing a well grown plant with numerous bolls. This also was sown on the Poona farm, and the seeds of the crop grown from it from the single plant seed and from the *Lália* seed have again been sown on the Poona farm in separate plots. As the crops ripen I will go through them and again select the best bolls from the best plants, and I hope to have selected seed of undoubted purity to begin with at Surat next year.

Degeneration of Surat cotton in the Deccan.

49. This year's crop grew vigorously and yielded well, but the lint is decidedly inferior to that produced at Surat. The fibre is coarse or harsh. The staple continues however long. I think the coarseness may be due to the plant being cultivated away from the soft sea breezes of Surat, in the dry and bracing atmosphere of the Deccan. The crop at Poona took longer to ripen than at Surat, most of the cotton being picked in March and a good deal of it in April and May.

The cotton plant lends itself stubbornly to any change, climatic or otherwise.

It is clear that cotton lends itself stubbornly to any change, and the introduction of a good variety into a district where inferior cotton is grown may not always be advantageous.

Sugarcane Experiments at Mánjri Budruk.

50. I give in Appendix I. a detailed note on the sugarcane experiments at Mánjri. The experiments cost approximately Rs. 4,000 in the first year. The expenditure includes heavy tillage expenses incurred by and paid to the previous occupant for bringing the field from waste into good tilth, rent for 1½ years, capital outlays for sugar-crushing mills, boiling apparatus, centrifugal sugar refiner, tillage implements, &c., and the cost of new varieties of cane from Mauritius. The expenditure in future, except for chemical manures, will be ordinary tillage expenditure, and I believe the cost to Government will be trifling. It is not likely that receipts will exceed expenditure, because the area is divided up into permanent small plots, the cultivation of which is necessarily greater than of an ordinary field. Moreover, the roadways and divisions between plots take up about one-fifth of the whole area. Weeds must be kept down on this vacant land, and the tillage expenditure on it is fully as heavy as on the land under crop.

Ordinary Crops not Experimental.

51. The following tabulated figures give the results for the year:—

Crop.	Outturn per Acre.		Cost of cultivation per Acre.	Value of outturn per Acre.
	Principal product.	Straw or useful by-product.		
	Lbs.	Lbs.	Rs. a. p.	Rs. a. p.
Bájri (Pennisetum typhoideum) and Tur (Cajanus indicus)	751 379	4,384 ...	24 13 0	50 2 0
Bájri alone	382	5,850	33 2 8	36 6 0
Gram (Cicer arietinum)	673	350	18 13 0	22 14 0

The necessity of resting mixed black soil from irrigation.

52. The above crops were grown for the benefit of rotation. The Bájri and Tur were grown to rest a field which had been under irrigation for some years. It is well known that black land in the Deccan requires occasional rest from irrigation, otherwise the crops become sooner or later unhealthy.

The disposal of Night-soil.

The Allahabad shallow-bed system of disposal.

53. This year I undertook on behalf of the Poona Cantonment Committee an experiment in the direct application of night-soil on cultivated land. The method of application was what is called the shallow-bed system. It is, I believe, practised successfully on the Allahabad grass farm. Beds are formed along one side of the area to be treated. The beds must be sufficient in number and extent to receive the night-soil of the following day or night. The beds are best made moderately small, one for each cart-load of night-soil. The soil inside the bed should be dug up and loosened, so that the liquid part of the night-soil soaks at once into the soil. If the beds are small, the semi-liquid night-soil as it escapes from the carts distributes itself equally. It should be covered immediately with three inches of soil, the soil being obtained by digging out the beds necessary for the reception of the night-soil of the following day. When sufficient soil is removed to cover the night-soil properly, the bottom of each bed should be dug up to loosen the soil. If the beds are properly prepared there is a guarantee that the night-soil is also sufficiently covered, consequently close supervision is not necessary. One inspection each day to see that the beds for next day's night-soil are properly prepared is all that is necessary.

54. The Poona night-soil carts have each a capacity of 200 gallons; probably on an average each cart contained about 120 gallons or say 1,400 lbs. Approximately 200 cart-loads were applied per acre, and it is certain that this was equivalent to 100 tons and probably 120 tons of mixed solid and liquid human excrement.

The quantity applied per acre.

55. The night-soil was applied between the 23rd June and the 9th July. There was hardly any noticeable smell when the night-soil was covered with the necessary quantity of soil and in a day or two there was nothing offensive or unsanitary.

No unsanitary conditions.

56. On the 29th of July, Jowári for a fodder crop was broadcasted by hand in the furrow behind a plough and covered by the soil moved in making the next furrow. The night-soil layer could be distinguished by its characteristic slate colour, the colour of poudrette. There was absolutely no taint or odour on its exposure at the surface. It had been buried 3 to 4 weeks. The experiment did not get a full and fair trial because (*a*) the land was secured by the Cantonment Committee too late in the season to get the full benefit of the rains; (*b*) the land was of light character and was unsuitable for growing any crop in the fair season without irrigation, and no water for irrigation was available; and (*c*) the season was unfavourable, the rains came late, and there were long breaks of dry weather most trying for all crops on light land and particularly so for a crop forced by a heavy dressing of manure.

The field of experiment not suitable and season unfavourable.

57. The crop throve vigorously as long as there was sufficient moisture in the soil and with timely showers would have been very heavy, but it withered as it matured. It yielded 1,133 bundles per acre of fair fodder worth about Rs. 45. Rain came immediately after the crop was harvested. A second crop from the previous crops' stubble grew, but was comparatively light.

Outturn results.

58. The practical utility of the system on good soil in the Poona district for ordinary dry crop cultivation is doubtful, because poudrette is saleable at a very high rate and moreover is more portable than night-soil and more easily applied as manure. In the Poona district the system might be economically applied for the cultivation of sugarcane and other valuable garden crops where irrigation facilities exist. Cultivators of sugarcane do not hesitate to use Rs. 200 to Rs. 250 worth of manure per acre, which is mostly poudrette carted from Poona. Unquestionably if the shallow-bed system of disposal be carried out unsanitary conditions are minimized. All the same, few people would like to see the system adopted in the vicinity of a populous centre, certainly not within a radius of three miles, and the cartage of night-soil that distance in various directions, even at night, would be seriously objected to by the public.

The practical utility of the system doubtful in the Poona district.

Implements and Machinery.

59. *Ploughs.*—I went to Adoni, Madras Presidency, specially to see a trial of turn-furrow ploughs on black cotton soil. Two agents of rival firms showed the advantages of their respective implements.

60. The Swedish turn-furrow plough specially strengthened was tried for the deep ploughing of black cotton soil set and fissured in the fair season. Ploughs made by Messrs. Massey and Co. of Madras were also tried. There is no need to compare the ploughs critically. All that need be said is that they did good work over the greater portion of a field; but part of the work was scamped in a manner which I will particularize further on. The indigenous plough of this part of India did most inferior work when tried against the turn-furrow ploughs, the same number of pair (six small pair) of bullocks being used for each. This indigenous plough is by no means an effective implement. It is in penetrating power and otherwise greatly

A trial of Swedish and Indian made iron Turn-furrow Ploughs at Adoni, Madras.

The indigenous Plough as seen at Adoni an inferior implement.

inferior to the heavy indigenous plough of the Deccan, and this is probably the reason why so many iron ploughs have been sold in Madras to *bonâ fide* cultivators. I bought a Swedish plough which I thought was doing better work than the others, and have tried it on the medium black soil of the Poona farm and on the deep black soil of the Surat farm. On the Poona farm it did fair work. On the Surat farm, 4 pair of powerful Gujarát bullocks were unable to draw it for any length of time. I brought a ploughman from Poona who was quite experienced at the work, and it was impossible that he or any other man could have continued to work a full day, it being almost impossible to hold the plough steadily in the soil. The field on which the trial was made had been lightly ploughed two or three times. The surface was loose, but the under-layer was hard set, but no harder set than the land I saw ploughed in Madras. I concluded that the black soil of Surat differs in some way from that in Madras. Certainly the former becomes so hardened in the fair season that no turn-furrow plough will do good work, and if it did, so little is done in a day that the work can be done better and cheaper by hand. In proof of this I had overgrown head-lands and other rough ground dug by hand by contract at about Rs. 25 per acre. The soil had set hard and a plough yoked with six pair of bullocks could not have ploughed ¼ acre per day. The labourers could with a hand-pick turn up huge clods. They could do the work best and cheapest when the soil had set, because it requires much less power (the pick being used as a lever) to turn up a huge clod than to dig the same volume of loose soil. The work is facilitated because the cracks allow entrance to the pick without labour. The Swedish or any other turn-furrow plough does good work when the soil is moderately moist, and with a pair of good bullocks half an acre can then be done in a day. A Deccan wooden plough can however be used sooner after rain and does as much work, perhaps it does not do as effective work, still it does very good work.

The Swedish Plough does not work so well on the black soil of Bombay as in the black soil of Madras.

The Swedish Plough fairly effective only at one season.

61. The great objection to the Swedish plough is that the ploughman cannot begin at one side of a field and make furrow after furrow until he finishes at the other side. With a native plough the furrow is not necessarily straight. The ploughman purposely continues it in a short curve along the head-lands at each journey of the plough across the field. Thus the head-lands (except the corners which are best dug by hand) are ploughed without any cross ploughing and with the least possible loss of time. Moreover the bullocks turn easier. With the Swedish plough the field has to be ploughed in sections or lands. In the dry season 3 or 4 pair of bullocks at least are required and two head-lands of considerable breadth must be left to allow the cattle room to turn. Plough cattle in the Deccan are trained to always turn away from the ploughed ground, and as they have to turn with a turn-furrow plough sometimes in one direction, sometimes in another, they get almost unmanageable at the ends unless old and very steady. A lot of time is wasted at the ends in drawing the plough along the head-lands whilst not actually doing work. The head-lands are at the best of irregular width, and when ploughed the work is almost certain to be badly done. As each land is finished a good deal of work is scamped, because as the unploughed ground between two adjacent lands gets narrow the cattle must walk over the rough surface of the ploughed ground and then they are unable to pull straight or to advantage. It may be argued that all these objections do not apply to work done during the rains or on moist easily moved soil. Even if this were so, what is the good of an implement that only works well at one season? It is most important to have an implement that will work well in the fair season, because it is most advantageous that black soil should be turned up into huge clods for exposure to the sun. The Swedish plough costs in Madras from Rs. 55 to 70 according to size and strength. In a comparative trial in the fair season at Poona, it ploughed seven-ninths of the area respectively covered by the turn-wrist plough and a heavy Deccan plough. The Deccan plough required an extra pair of bullocks. The soil was medium black and fairly set.

The disadvantages of a Swedish Plough when compared with a good indigenous Plough.

It is of great advantage to Plough black soil in the fair season.

The price of the Swedish plough.

The extent of work done by a Swedish, a Turn-wrist, and a Deccan Plough compared.

62. *Ransome's Turn-wrist Plough.*—This plough, in my opinion, is better suited to the conditions of Indian agriculture than any other turn-furrow plough which I have seen or tried. It is of undoubted strength and durability. It does capital work on any kind of soil, which in respect of moistness is in good condition for ploughing. It can be used with as good effect as the best indigenous plough on black soil which has become hard and fissured in the dry season. If the late rains fall in October-November, it will work up to the end of February, but not later except in fields which have been under irrigation. The draft is less than that required for a heavy Deccan plough. Four pair of bullocks in a turn-wrist plough will do equal work with six pair of bullocks in a Deccan plough in deep cotton soil. In each case huge clods are turned up. But only about one-fourth acre is done in a day. This year the turn-wrist plough yoked with two pair of bullocks ploughed the sugarcane experimental field at Mánjri soon after the crop was harvested. Such land although moist is very difficult to plough owing to the root stocks of the sugarcane having a firm hold of the ground. The plough did the work as effectively and as expeditiously as a native plough with five pair of bullocks. Each implement is capable of doing good work. The draft of the turn-wrist plough is much lessened by the combined action of the coulter and share cutting through and dislodging the tough root stocks. The mould board completes the dislodgment. In sugarcane cultivation, a saving in bullock-power is of great importance, because the crop is a 11½ or 12 months' crop, and the field should be ready for re-plantation as soon as possible after harvest, because the crop can only be seasonably planted in January, February or March.

A good Plough.

63. The chief advantage which the turn-wrist plough has over any other turn-furrow plough is that it ploughs the field in precisely the same manner as a native plough. The mould board and share by an ingenious arrangement can easily and quickly be adjusted on one side of the plough as it goes in one direction and on the other side as it returns. Therefore the opening furrow is made along one side of the field, and furrow alongside furrow is turned until the whole field (inclusive of the head-lands but excepting the corners) is ploughed. At each forward and backward journey of the plough one of each pair of bullocks walks alternately on the rough ploughed ground and on the smooth unploughed ground, and the bullocks do not get foot-sore to the same extent as if yoked to an ordinary turn-furrow plough, in which case the same bullock or bullocks would continue walking on the rough ground all day, unless the ploughman took the trouble to unyoke and give the bullocks turn and turn-about on the rough ground.

The special advantages of the Turn-wrist Plough.

64. The turn-wrist plough is made of three sizes, the cheapest being, at current rate of exchange, worth about Rs. 45 in England.

Cost.

65. It is not likely that it or any other turn-furrow plough will be taken up by the cultivators in the Deccan except for sugarcane cultivation, the reason being that the indigenous plough is by no means the ineffective implement it is sometimes called. It might with every advantage be introduced to many other parts of India.

Not likely to be adopted by cultivators except under special circumstances.

66. *Centrifugal Sugar Refiner.*—We were unable to give this machine a full trial this year. It was received when a considerable portion of the sugarcane crop was harvested. It was found to require repairs before it worked satisfactorily, being an old machine.

Not yet fairly tried.

67. It separates the treacle from the crystalline sugar by centrifugal force. A drum revolves at a high speed inside an outer shell. The speed is sufficient to throw the sugar and molasses against the perforated sides of the drum. The treacle is forced through the minute perforations and the sugar remains. By sprinkling with water the sugar can be further purified, the last of the treacle being thus conveyed away. The treacle drains to the bottom of the shell and flows through a hole and may be collected in a vessel set under the machine. When the sugar

The manner in which it works.

is seen to be of a clear white colour, the machine should be stopped, the sugar removed, and the machine re-charged. It takes about five minutes to separate the treacle thoroughly from the sugar. The best results were got when the sugar layer against the sides of the drum was $\frac{1}{4}$" to $\frac{3}{4}$" thick. When a larger charge of semi-liquid Gul than what represented this thickness of sugar was put on the drum, the sugar could not, without much extra work, be quite freed from treacle by washing; and if more water than is necessary is sprinkled into the drum, it dissolves part of the crystalline sugar and carries it as well as the treacle away through the perforations. Our trials were not complete enough to determine at what stage the boiling of the sugar-cane juice should stop in order to give the best results. It was clear that the boiling should not continue as long as is necessary to produce solid Gul (crude sugar). It must stop at an earlier stage, and the proper stage has yet to be determined.

The consistence of the Gul which gives best results has yet to be determined.

It was made quite clear that Gul as generally prepared is not a very clean product. The solid impurities do not escape with the treacle, but remain in the sugar and are much easier seen in the white sugar than in the *gul*. It is perhaps impossible to prevent impurities entering the boiling pan during the boiling process under the present system, because the pans are large and open, and when wind is blowing in a certain direction, particles of fuel and smoke are carried directly over the pan. The skimming during boiling is supposed to remove impurities, and does so most effectively if a mucilaginous extract from the *bhendi* (Hibiscus esculentus) plant is mixed with the juice when boiling begins or at a later stage. It would no doubt be advantageous to pass the juice through a sieve or strainer as it is poured into the pan. These points will receive attention when further trials are made.

Gul as generally prepared is not a clean product.

68. So far as our trials have gone, we have not been able to get sugar in paying quantity. From a given weight of semi-solid Gul we only got 25 per cent of white sugar. The treacle by re-boiling can be made into good solid Gul, which proves that a good deal of the crystallizable sugar escaped with the treacle. If 50 per cent of white sugar could be got, the use of the machine (with Gul at its present rate) would be distinctly advantageous. Fine crystalline Mauritius sugar commands the same price only as sugar very inferior in quality, but purified in the native way. Imported sugar is objected to by strict Hindus, because animal charcoal may possibly have been used to purify it.

The percentage of sugar was too small to pay.

Imported sugar objected to by strict Hindus.

69. The following figures would show the advantage of the centrifugal sugar refiner if it produced 50 per cent white sugar :—

Figures to show that the centrifugal machine may or may not prove useful.

240 lbs. Gul is worth now Rs. 12 and may be worth Rs. 15 later in the season.		
120 lbs. of refined sugar is worth...		Rs. 12-8
120 lbs. of treacle if re-boiled and converted into Gul is worth		„ 3-8
	Total ...	Rs. 16-0
Deduct cost of making sugar, cost of one sack, and cost of re-boiling treacle ...		Re. 1
	Balance ..	Rs. 15

There would thus be an advantage of three rupees per *palla* if Gul gets no dearer than its present rate of Rs. 12 per *palla* (*i. e.* 240 lbs.).

70. If we get no better results than we have got so far, the centrifugal machine would be worked at a loss as shown by the following figures ;—

240 lbs. Gul worth		Rs. 12 0
60 lbs. sugar worth	Rs. 6 4	
180 lbs. treacle worth	„ 5 4	
	Total ...	Rs. 11 8
Deduct cost of manufacture &c.		Re. 1 0
	Balance ...	Rs. 10 8

There would thus be a loss of Re. 1-8 per *palla* of 240 lbs.

The native method of refining sugar a dirty process.

71. The native method of refining sugar is a very filthy process, but it answers financially, because 50 per cent of crystallized sugar is reported to be obtained. The jagri in a semi-solid state is placed in large bamboo baskets about 7 feet in diameter and 3½ or 4 feet high. The baskets are supported 3 or 4 inches from the floor. The treacle drains away through the wicker work and collects in a reservoir or pit placed so that the treacle of several baskets may collect there. The treacle is sold at 7 or 8 rupees per 240 lbs. for the manufacture of country spirit. A superlayer of purified sugar of about one inch in thickness is scraped off daily from the contents of each basket. The sugar is placed on a cloth, exposed to the sun, and trampled under the feet of coolies until it is reduced to a dry and granular condition. The coolies take short steps and give a twisting action to their feet. The trampling is necessary, because the presence of small solid yellow lumps reduces the market price of the sugar. A moist layer of *sheval*, a weed or moss which grows in streams, is spread over the jagri in the baskets and has the effect of clearing the surface sugar of treacle. The moss layer should be renewed every two or three days. It takes a month or more before all the treacle from one basket drains away, and the sugar got from the basket towards the end of the process is not so good as that taken out previously.

Poona Farm Accounts.

72. The farm accounts have been kept distinct from the dairy and dairy herd accounts. Two balance sheets are appended showing the financial results of each. The farm balance sheet shows that the net cost to Government has fallen from Rs. 1,484-8-11 last year to Rs. 611-12-8 this year.

Dairy and Dairy Herd.

73. The financial results are shown in the appended balance sheet. The profit for the year is Rs. 266-11-6 as against Rs. 2,254-13-2 last year.

Rinderpest.

74. The reason why the margin of profit is so small is due to a very serious outbreak of rinderpest during the year. If reference is made to Appendix V. it will be seen that 54 cattle died during the year; of these one cow (our best Aden) was poisoned (intentionally I believe), one cow died from inflammation of the lungs, and a few calves were lost, as they ordinarily will be. There were 34 deaths due directly to rinderpest, and some calves which recovered from the disease died from after-effects. They never recovered their strength though well cared for. The indirect loss due to diminished milk yield in the healthy cattle was probably more than that from death. The disease first broke out amongst unweaned calves, and these had necessarily to be separated from their dams. The maternal instincts of Indian cattle are very strong, and the effect of separation from the calves upon the milk yield, especially of the buffaloes, was remarkable. The cattle were in full milk at the time, the whole herd giving about 700 lbs. daily. A week after the rinderpest appeared the daily yield was about 450 lbs., representing a daily loss of 18 rupees. It seems to be practically impossible to wean calves at birth from Indian milk cattle unless done when the heifer has her first calf, but the above results point to the necessity of doing so if possible. The carcasses of the cattle that died were all burnt. This with medicines cost Rs. 266.

The effect of separating suckling calves from their dams.

The death-rate.

Exotic cattle more susceptible of contagion than the indigenous.

The number of deaths was about 70 per cent of affected cases. It is significant that indigenous breeds escaped contagion to a far greater extent than exotic breeds. An English cow and calf belonging to His Excellency the late Governor were about the first to succumb. Two Bahrein cows of a noted milk-breed which I had bought at considerable expense from the head of the Persian Gulf, died within thirty hours of the first symptoms. Every Aden which came in contact with contagion became infected and died. We lost one Sind cow, but no Gir

cattle, and only two buffalo-cows, though a number became infected, but only in a mild manner. Young buffalo and cow-calves died very quickly. Cows advanced in pregnancy were hopeless cases. Symptoms of abortion became apparent and inversion of the uterus resulted in every case. We had a *post-mortem* examination on one of these cases, and the fœtus was found to have characteristic rinderpest symptoms.

Cows advanced in pregnancy died very quickly.

As far as I could judge, careful veterinary treatment did very little good. The most effective medicine was carbolic acid given in gruel, its influence being a healing one on the highly inflamed membranes of the intestines. I believe the cure of cases to have been chiefly due to careful nursing and to drenching the animals with good gruel. The gruel consisted of linseed boiled with rice, fresh separated milk, and water.

Veterinary treatment apparently not so important as careful nursing.

75. We got rid of the disease by segregation. The apparently healthy animals were moved at once from the farm buildings where the disease was first observed to a grass *kuran*. Here disease made its appearance in about seven or eight days, that period being I think the period of incubation.

The importance of segregation.

The healthy cattle were moved a second time to another grass *kuran* about a mile distant, and here they were kept for about three months. Meantime the byres were re-floored and the whole surroundings disinfected—crude carbolic acid being used on floors, drains, and manure heap, tar for wood work, and white-washing for walls.

76. The disease was disastrous at the farm, but I can conceive that it was far more so in the city of Poona and the surrounding villages where it was rife. Under existing conditions the spread of contagion is not only absolutely uncontrolled, but is encouraged. The Mhárs eat the flesh of animals that die and they offer the diseased skins in any market where they can get a good price. The carcass is generally cut up on the bank of a *ndla* or stream and the offal is left there as a centre of contagion for every healthy animal that grazes in the vicinity. It is common knowledge that when outbreaks of rinderpest occur they generally spread along the course of streams or rivers. These are points affecting the healthiness of the cattle of the country. But there is another question, *viz.*, that which affects the public health. It is absolutely certain that milk from cattle suffering from rinderpest was sold in Poona to the public during the prevalence of the disease. There is some comfort in the fact that as regards buffalo's milk, the public have some protection, inasmuch as a buffalo, unlike a cow, when infected with rinderpest or ailing in other ways, almost always refuses to give any.

The manner in which the disease is spread.

The danger to the public health by the sale of milk from diseased cattle.

77. The dairy produce from about seventy milch cattle was sold for Rs. 15,303, cattle food, fodder, and grazing cost Rs. 10,968. There was a stock of fodder on hand at the end of the year worth Rs. 1,507. If the dairy herd keeps healthy there will be no difficulty in any year in making the dairy a profitable institution. The price of dairy produce supplied to the Commissariat Department for sick soldiers in hospitals is lower than the rates charged to the public. The latter rates are fixed purposely higher than the rates of private dairymen in Poona. Yet we could sell to private families to a much greater extent than is done now if there was an available supply, which there is not.

Ordinarily there should be no difficulty in making the dairy a profitable institution.

The farm dairy may interfere with the trade of private dairymen, but only because we supply purer and cleaner milk and better butter than they can do, and the public do not hesitate to pay higher price for the superior article. This should stimulate native enterprize to supply what is required, but in many cases I am afraid it does not.

Beneficial interference with private enterprize.

The City of Bombay is at present the great centre of butter-making for India and also for export. It is almost impossible to make good butter in India without using ice except in the cold weather. Ice in Bombay is not dear. But it is not used by many dairymen, consequently the butter is churned so soft that it cannot be worked on the butter-worker and therefore contains butter-milk, which will soon cause rancidity. If sold for immediate consumption, there is no great harm done excepting that the butter contains water and other impurity to a far greater extent than it ought to do. This adds to the weight, naturally to the satisfaction of the dairyman. The same butter if salted and packed in tins for export or for the use of district officers will certainly not keep good long.

The extension of dairying in Bombay not altogether satisfactory.

78. It is extremely satisfactory to note that the initiative example of the Agricultural Department started the dairy enterprize in Bombay, but it is unsatisfactory to know that the enterprize although it has assumed enormous proportions (about 3 lákhs rupees worth of dairy apparatus having been sold) will inevitably come to grief unless many of those employed in it will mend their ways. The use of improved dairy machinery has made it possible to make butter in Bombay and elsewhere from cream separated in remote districts where milk is cheap; but the manner in which the cream is transported and the usual filthy condition of the vessels (there may be exceptions) leaves a great deal to be desired. In connection with our own operations the cleaning of milk vessels requires persistent supervision.

The advantages of the Mánjri Stock Farm.

79. The Mánjri stock farm is an adjunct of the Poona farm which will prove of very great value. It affords us every facility for the healthy up-bringing of our young stock. We have now fair scope and good opportunities to prove whether the milk-breeds of India can be bred up to a better standard than the present one which is in respect of selected cattle (especially buffaloes) by no means low.

Breeding for milk does not necessarily mean that the male offspring of our best milk-cows will not be good plough cattle. On the contrary, we expect to be able not only to breed good plough cattle, but heifers which when they come into profit will be better milkers than their dams.

The disposal of young bulls for stud purposes.

80. I have no hope that the bulls, the produce of our best milch cows, will ever be used with advantage for improving the Deccani breed of cattle. I would object to see them used for this purpose, because I believe the small indigenous hardy Deccan breed is the outcome of natural conditions. The greater portion of the Deccan is subject to famine and often to periods of scarcity, and there is no hope that a larger and softer breed would survive these trying seasons unless the fodder and food supply is improved, and how that can be done to any great extent is difficult to conjecture. I see no practical method of improving the Deccan breed (which is notoriously inferior as plough cattle) except by using only the best indigenous bulls.

81. Gaolis (professional milk-men) are keen to buy our young bulls. They like the Gir bulls best, but do not object to the Sindis. The Adens they consider too small. The Gaoli likes the Gir bulls best because they are big enough to take a good load in a single cart, the cart being used to carry the milk to the sweetmeat-makers in the bazár or elsewhere and carry back the concentrated food required for the cattle. These bulls are also used for stud, chiefly on Gir cows brought, because they are good milkers, from Káthiáwár. The calves of these cows are well cared for, because the owner knows that a heifer will grow into a good milk cow and a good bull will in time be worth Rs. 75 to 100. The effect of the sire is just as potent as that of the dam in breeding for milk, and for this reason I think the sale of young bulls from our best milk cows to professional milk-men must do good. I sold a Sind bull to each of two dairy farmers at Ahmadnagar and a Gir bull to one of them. I also sold a farm-bred Gir bull for the use of the dairy herd of the Central Jail, Jabalpore, and four were sold to Poona milk-men. These were all that were ready for sale.

82. I could not in the report refer, except at considerable length, to experience gained about dairy cattle. It is unnecessary for me to do so as I have written for the Agricultural Ledger Series a full note on the management of

dairy cattle and young stock in India and another on milk and milk products. These publications are printed and will soon be circulated or can be had on application.

The milk-yield of the Dairy Herd.

83. I submit below two tabulated statements which give details of the milk-yield of buffaloes and cows during the year :—

Cows.

No.	Names.	Breed.	Date of Calving.	Number of days in Milk.	Maximum yield.	Average yield.	Total yield.	Date of birth of next calf or due to calve.
					Lbs. oz.	Lbs. oz.	Lbs. oz.	
1	Amini	Sind ...	16th May 1893 ...	431	19 8	9 14	4,249 4	14th Aug. 1894.
2	Káveri	Do. ...	25th Dec. 1893 ...	446	13 12	8 9	3,834 0	23rd June 1895.
3	Sábarmati ...	Do. ...	16th Jan. 1894 ...	359	16 8	11 10	4,179 0	14th Jan. 1895.
4	Kousáli	Do. ...	6th May 1893 ...	442	22 4	12 11	5,607 12	8th Aug. 1894.
5	Dovri	Do. ...	21st ,, 1893 ...	420	19 12	11 2	4,705 4	3rd ,, 1894.
6	Rakhmi	Do. ...	25th ,, 1893 ...	424	14 8	8 13	3,732 8	30th Oct. 1894.
7	Jánki	Do. ...	18th ,, 1893 ...	406	17 12	8 9	3,481 4	21st July 1894.
8	Krishni	Do. ...	13th Dec. 1893 ...	337	12 8	7 6	2,492 6	3rd Feb. 1895.
9	Pándi	Do. ...	14th May 1893 ...	410	21 0	9 3	3,757 0	14th Aug. 1894.
10	Gowlan	Gir... ...	16th Feb. 1894 ...	375	22 8	10 3	3,819 0	14th April 1895.
11	Sárja	Do. ...	5th Dec, 1893 ...	215	20 0	18 3	2,830 0	Died on 9th July 1894.
12	Lakshmi	Do. ...	1st March 1894 ...	293	15 8	5 1	1,474 4	10th Dec. 1895.
13	Thaki	Do. ...	22nd Feb. 1894 ...	281	14 8	6 14	1,936 12	13th July 1895.
14	Náráli	Do. ...	8th Jan. 1894 ...	240	15 0	9 8	2,273 12	30th Dec. 1894.
15	biti	Do. ...	18th Sep. 1893 ...	308	16 12	9 6	2,878 4	26th Oct. 1894.
16	Jamni	Aden ...	12th July 1893 ...	344	16 12	12 3	4,185 8	7th Aug. 1894.
17	Damayanti ...	Do. ...	2nd June 1893 ...	380	12 4	6 3	2,366 8	27th Oct. 1894.
18	Bhági	Do. ...	22nd Nov. 1893...	219	7 0	4 10	1,019 12	12th Oct. 1894.
19	Mori	Cross ...	9th Dec. 1893 ...	414	10 0	5 15	2,480 12	Died on 23rd December 1894.
20	Tári	Do. ...	19th July 1893...	341	15 4	8 4	2,814 6	Do. do.
21	Chandrával ...	Half Aden .	18th Aug. 1893...	307	11 8	5 13	1,792 8	29th July 1894.

Buffaloes.

No.	Names.	Breed.	Date of Calving.	Number of days in Milk.	Maximum yield.	Average yield.	Total yield.	Date of birth of next calf or due to calve.
					Lbs. oz.	Lbs. oz.	Lbs. oz.	
1	Champa	Jáfarabad ...	28th May 1893 ...	446	23 0	15 12	7,011 0	24th Aug. 1894.
2	Thami	Do. ...	1st Sep. 1893 ...	303	19 8	9 14	3,039 8	25th Nov. 1894.
3	Ratan	Delhi ...	12th April 1893...	431	27 0	16 4	7,004 12	19th Sept. 1894.
4	Bhori	Surat ...	20th Oct. 1893 ...	506	21 4	11 8	5,841 12	14th Sept 1895.
5	Lali	Do. ...	18th Jan. 1894 ..	370	19 8	13 7	4,960 12	6th Feb. 1895.
6	Thaki	Do. ...	11th Feb. 1894 ..,	411	18 8	12 12	5,252 8	16th Oct. 1895.
7	Tuphán	Do. ...	30th Oct. 1893 ...	292	14 4	9 9	2,787 12	16th Nov. 1894.
8	Tikkal	Do. ...	18th July 1893 ...	463	15 4	10 4	4,738 12	14th Dec. 1894.
9	Kapili	Do. ...	12th Sep, 1893 ...	489	12 12	10 11	5,221 12	9th Nov. 1895.
10	Kamali	Do. ...	15th Dec. 1893...	319	12 0	9 4	2,947 8	27th Aug. 1895.
11	Mahitáb	Do. ..	24th Sep 1893 ...	288	14 8	5 10	1,621 4	2nd Oct. 1894.
12	Asmán	Do. ...	20th Nov 1892 ...	585	13 8	8 11	5,086 0	6th Aug. 1894.
13	Anandi	Do. ...	28th Sep. 1893 ...	451	12 8	7 8	3,241 0	28th Sept 1894.
14	Chakkar	Do. ...	6th May 1893 ...	353	27 8	14 13	5,222 8	13th May 1894.
15	Rupa	Do. ..	15th Dec. 1892 ...	588	29 0	9 5	5,488 0	.....
16	Khandi	Do. ...	20th Jan. 1893 ...	487	24 8	11 11	5,681 12	6th Nov. 1894.
17	Mukhran	Do, ...	15th Jan, 1893 ...	493	13 8	7 14	3,876 0	21st Feb. 1895.
18	Lahiri	Deccan ...	3rd Nov. 1893 ...	416	17 4	11 14	4,940 12	30th Nov. 1895.
19	Diváli	Do. ...	6th March 1894...	326	18 4	12 7	4,046 8	16th Jan. 1896.
20	Zendi	Do. ...	1st Dec. 1893 ...	324	10 12	7 8	2,428 4	13th Jan. 1895.
21	Mirga	Cross ...	15th Dec. 1893 ...	326	18 8	12 7	4,059 12	5th March 1895.
22	Hira	Do. ...	15th Feb. 1894 ...	258	14 4	9 3	2,367 12	6th August 1895.
23	Dashrath	Do. ...	7th Jan. 1893 ...	659	16 0	9 4	6,305 0	22nd Feb. 1895.

No. 6 giving 3 lbs. 4 ozs. of milk on 1st April 1895.

84. The average number of days between two calvings were as under :—

Jáfarabadi buffaloes	...	...	...	451
Surat	,, ...	...	...	522
Deccani	,, ...	...	...	615
Cross-bred	,, ...	...	...	461
Delhi	,, ...	...	...	525
Gir cows	... ...	...	...	467
Aden cows	... .	...	...	409
Cross-bred Aden cows	...	...	...	345
Sind cows	... ...	...	...	454

85. Below I give the average number of pounds of buffalo's milk required to make a pound of butter during each month in the year. It will be noticed that a less quantity of milk is required to produce a pound of butter in the hot season when green fodder is scant than during the rains when it is more plentiful :—

Months.	Milk in lbs.
April	11·3
May	10·9
June	11·3
July	12·0
August	11·4
September	12·7
October	11·6
November	11·2
December...	11·7
January	10·7
February...	10·5
March	11·1

Sheep.

86. We have crossed a small flock of Deccani ewes with a Dumba ram with very satisfactory results. We are gradually increasing the flock to give full work to a capable shepherd. The Dumba-Deccani cross-bred is a remarkably good mutton-sheep with a good coat of wool. I do not intend to use the Dumba beyond the first generation. The cross itself is good enough to go on with. We kept two of the best ram lambs for stud and sold all the others (nine) to one of the Military Messes in Poona at Rs. 8 each, which was equivalent to about 4½ annas per lb. of dressed carcass, the best mutton selling in the bazár at 6 lbs. per rupee. Good young Deccan ewes can be bought at Rs. 3 or Rs. 3-8-0 each.

Establishment.

87. Mr. Kelkar, my Assistant, has as hitherto taken keen and active interest in his work and is a capable farm manager. My clerk, Mr. Kánetkar, and the Farm clerk, Mr. Kulkarni, have both done well. Their time is only partly occupied with office work. Both get full opportunities of gaining practical knowledge, and the former helped me well during the harvesting of the experimental sugarcane, in dealing with weighments and the recording of results. Mr. Káshináth, the overseer at Mánjri, has done good work both in looking after the young cattle and in attending to the cultivation operations in our experimental sugarcane.

I have the honour to be,
Sir,
Your most obedient Servant,

J. W. MOLLISON,
Superintendent of Farms,
Bombay.

APPENDIX I.

A DETAILED NOTE ON THE SPECIAL SUGARCANE EXPERIMENTS AT MANJRI.

Area selected for experiments most suitable.

The series of sugarcane experiments begun in 1894 have, in their first year, given results which are of special interest and value. The results are fairly concordant with expectations, and I am quite satisfied that the field selected for experiment has been well chosen. This is of special importance, because it is in the centre of a large area almost exclusively cultivated with cane. The cultivators of the district are well-to-do and skilful, and have evinced considerable interest in the results of last year, and I have no doubt in future years our experimental plots will attract a good deal of local attention.

Scheme of experiments to be extended.

2. Government have sanctioned the purchase of the field, also of adjoining lands, to admit of the scope of the scheme being extended. Thus the experimental area can be permanently occupied or at least until definite issues are obtained.

Arrangement of plots.

3. There are thirty plots on the present experimental area which are permanently marked and numbered. Next year the additional area to be acquired will be laid out, so that there will be about forty plots in all. There are vacant places between plots five feet in width. These with the roadways necessary for easy access to each series take up a good deal of ground—about one-fifth of the whole area. The spaces between plots undergo practically the same tillage as the plots, excepting that the former receive no manure, but are more frequently weeded than the latter.

Necessity of binding up the cane to prevent lodging by wind or rain.

4. In a field entirely planted with cane, it is usual to find the canes on the head-lands leaning over towards the borders of the field, whilst the canes throughout the main portion of the field maintain an upright position, because standing thick on the ground they support each other. Heavy rain or high wind may lodge an exceptionally good crop. On our best plots the cane was to a considerable extent lodged by heavy rain and high wind, chiefly because the wind and rain had greater effect on account of the vacant spaces between plots. The practical lesson learned is that the crop on each plot must in future years, when half-grown, be tied up, *i. e.* four to six canes will be bound loosely but securely together, about four feet from the ground, by a twisted band of dried leaves stripped from the cane. This practice prevails to a considerable extent in Gujarát, and in respect of our experimental cultivation, becomes absolutely necessary, because it is known by cultivators that upright cane contains a higher percentage of sugar than lodged cane, and this fact has been corroborated by Dr. Leather's tests (*vide* page 41).

The percentage of sugar greater in upright cane than in lodged cane.

Tillage operations costly in the first year.

5. The field owing to a fortuitous circumstance had not been cultivated for some years. The cost of bringing waste land into proper tilth for sugarcane is heavy. The tillage operations of the first year have cost much more than they will in future years, and are much in excess of what they ordinarily would be. It may be accepted that the tillage of the plots and the spaces which divide them must cost per acre always considerably more than a field under ordinary cultivation.

Differences in cost of cultivation due to intentional differences in treatment of plots shown in tabulated statements of results.

6. In the comparative manure series, the per acre cost of manures applied to the different plots varies considerably. Again, in other comparative plots, there are differences in cost of cultivation due to intentional differences in treatment. The prices at which different manures can be bought depend upon supply and demand and may

vary considerably from year to year. In the tabulated statements of results the differences in the cost of cultivation due to the varying prices of the manures applied or to other intentional differences of treatment are shown.

First Series.

Trashing, wrapping, and tying up cane.

7. *Object.*—To test the value of trashing, wrapping, and tying up cane as practised at Bassein and elsewhere with the ordinary Poona method of cultivation; also to test the comparative value of American sugar sorghums.

The American sugar sorghum comparatively a failure as a sugar crop.

8. The American sorghum has failed to prove itself a useful sugar crop. The failure cannot be attributed to want of acclimatization, because the crop under experiment was the fourth generation from imported seed. The variety tested is reported to yield, in America, from the nearly mature stalks 15 per cent of sugar. Here it only gave 8·29 per cent of treacle, from which only a small percentage of sugar crystallized out. The treacle was not saleable except at a very low rate, and was used to sweeten the concentrated food of our dairy cattle. It was worth a fair price for this purpose, and the cattle relished the sweetened food. It was intended to grow two sorghum crops in comparison with one crop of cane, one sorghum crop to be a rain crop without irrigation, and the other a cold weather irrigated crop. The former grew well, whilst the latter failed completely though sown twice. The young seedlings died soon after germination. The failure was due, I think, to the wide difference between the day and night temperature. If the rain crop had been saved for fodder, the produce would have been worth much more than the molasses. The cost of removing the tops and stripping of the green leaves in preparing the sorghum stalks for the mill is much more per acre than in the case of cane; because on a given area there are probably ten stalks of sorghum to one of cane. I have tested the sorghum as to the proper seed rate for a sugar crop, also as to the stage of growth when the stalks yield the most sugar, and I regret to report that under no circumstances can the American sorghum compete with sugar-cane in the Poona district, and it is doubtful if it can anywhere in India be grown profitably for sugar. On the other hand, this exotic sorghum ranks as a fodder crop one of the very best that can be grown in the Deccan. The results from the sorghum rain crop are given below:

A very promising fodder crop.

1st Series, Plot 1, $\frac{1}{6}$ Acre.	Per Acre. Lbs.
Weight of crop...	32,195
Do. stalks with tops and side leaves removed ...	22,820
Do. tops and side leaves, useful as fodder	9,375
Do. juice per acre	16,612
Do. treacle	1,892
Percentage of treacle to cane	8·29

Trashing, wrapping, and tying up not an economical practise in the Poona district.

9. The following tabulated figures give the results from cane cultivated in the ordinary Poona manner and from cane trashed, wrapped, and tied up. Plots each one-fifth acre:—

Number of Plot.	Treatment of crop.	Weight of cane stripped and topped per Acre.	Weight of tops per Acre.	Weight of Gul per Acre.	Cost of special treatment per Acre.	Value of Gul per Acre.
		Lbs.	Lbs.	Lbs.	Rs. a. p.	Rs. a. p.
2	Ordinary cultivation ...	95,270	12,280	12,070	Nil.	622 2 7
3	Cane trashed, wrapped, and tied up	94,065	12,215	11,845	45 0 0	610 8 9

Each plot was manured with 42 tons poudrette per acre. To all appearance the crops were perfectly even until the cane of Plot 3 was trashed, wrapped, and tied up. The effect was a decided check to the crop, the younger leaves becoming distinctly lighter in colour. I can give no satisfactory reason for this, excepting that the work was done at a later stage of growth than at Bassein (near Bombay), where the practice prevails. The reason why the work was done late was that cane at Bassein is planted two months later than at Poona; whilst the trashing, wrapping, &c., must be deferred at either place until the rains cease. I brought an expert at the work specially from Bassein, in order that our own labourers might see the work properly done and learn. The practice might be proved advantageous in the Deccan in the case of isolated fields, because the tying undoubtedly prevents a heavy crop from being lodged by wind or rain, whilst the wrapping protects the cane to a considerable extent from destruction by rats, jackals, and pigs, especially the two latter. The cultivation of cane in the neighbourhood of our experimental field is so extensive, that the damage done by the animal pests referred to above is comparatively trivial in any particular area, though extensive enough on the whole. For this reason the wrapping did not pay. It has been decided that this year's results in Series No. I. have given conclusive results, both as regards the American sorghum and the value of trashing, wrapping, and tying up. Therefore there is no object in continuing the experiments, and Plots 1, 2, and 3 have in this year been added to the comparative manure series in order to extend it.

Wrapping, &c., might prove economical in isolated fields.

Reasons why wrapping does not pay in the Poona sugarcane area.

Second Series.

Comparative Manure Experiments.

10. *Object.*—To test the comparative values of such manures as are within the reach and means of ordinary cultivators, and when the effects of the various manures tried have been clearly demonstrated, then to determine whether two or more of the manures used cannot be judiciously combined so as to secure economy without diminution of net profit.

11. The weight of manure applied to each plot to be regulated by the percentage of nitrogen it contains. Equivalent weights of nitrogen to be applied to each plot. The percentage of other elements of value will be known, and any marked difference between the crops of the various plots will no doubt be traced to the value of elements other than nitrogen. These differences will eventually regulate the manner in which two or more manures may be mixed with the object of reducing cost and getting equally good results.

Equivalent weights of nitrogen to be applied to comparative manure plots.

Count to be taken of other elements of nutrition.

12. In the year under report poudrette was taken as a basis, and of this manure 42 tons per acre were applied. Dr. Leather, the Agricultural Chemist to the Government of India, could not, owing to insufficient time, complete the analyses of the manures before they were applied. The plots necessarily had to be manured in February-March to admit of the cane being seasonably planted, and arrangements as to the renting of the land were only completed a short time previously.

Poudrette taken as a basis.

13. The quantity of manure applied to each plot was fixed in relation to the reputed percentage of nitrogen in each kind of manure, but subsequently Dr. Leather found that the reputed percentage of nitrogen varied very considerably from the actual in almost all the manures applied.

Reputed percentage of nitrogen in the manures used differs greatly from actual percentage.

14. There is no definite relationship between the value of the manures as determined by chemical analysis and their actual commercial value. The price of a manure should chiefly depend upon the percentages of nitrogen, potash, and phosphoric acid, and the condition in which these constituents exist. Organic matter present in a

No definite relationship between the cost of manures and their chemical composition.

high percentage, as in cattle dung, would of course add appreciably to the value of the manure. It is certain that the cane cultivators of the Poona district, though they are much over average in intelligence, fail to recognise the differences in manurial value of the manures they use. In support of this I note the fact that castor cake has doubled in price in the Poona district during the last three years; whilst poudrette (against the use of which there is no prejudice) has not risen appreciably in value. The chemical analysis of these manures would indicate that castor cake in comparison with poudrette is exceedingly dear. This fact becomes the more anomalous when it is known that poudrette is perhaps four times dearer at Poona than at any other populous centre of the Presidency. At Surat the town manure, consisting largely of night-soil, is worth 8 to 12 annas per cart-load as compared with Rs. 3 at Poona. The Surat poudrette is not strictly comparable with that at Poona, because it is manufactured in a different manner; but at both places it is readily bought by Kunbis for the extensively irrigated crops of the neighbourhood, and at both places castor cake is also largely employed. The price of castor cake cannot differ to any great extent between districts because castors are widely cultivated and the cost of transporting the cake by rail a considerable distance is not great. Poudrette is dear in Poona because of the keen demand for it. Yet dear though it is, the men who buy it at Rs. 3 a cart-load and cart it four to eight miles often make the dung of their cattle into fuel cakes to be sold in Poona. The inference is that cattle dung at Poona is worth as fuel a better price than as manure, the manure if well decayed being worth at best Rs. 4 per ton. Bones in the Poona district have trebled in value during the past three years, owing entirely to the extrinsic circumstance that there is a keen demand for export.

Cane cultivators in the Poona district fail to recognize the differences in manurial value of the manures they use.

15. There are several edible oil cakes now used for feeding cattle in India and largely exported which can be bought in Poona at a considerably cheaper rate per ton than the castor cake and Karanj (Pongamia glabra) cake now so extensively employed as manure. Dr. Leather's analysis proves that the edible cakes contain much higher percentages of nitrogen (the most valuable constituent of manures) than the manure cakes, and in our extended scheme of comparative manure experiments started in the current season, the value of the edible cakes as manure is being tested. I had no hesitation in proposing this trial, because these edible oil cakes are either exported and thus lost to the country or they are chiefly fed to milch cattle in large towns. The solid and liquid excrement of these cattle is not used as manure. The urine drains away somehow, whilst the dung is sold (in Bombay, for instance, at 8 annas a cart-load) to be converted into cowdung cakes and burnt as fuel.

Some of the edible oil cakes much cheaper per ton and contain a much higher percentage of nitrogen than manure oil cakes.

A plea why edible cakes should be directly used as manure.

16. The result of Dr. Leather's analysis of the manures applied last year and in the current season, considered in conjunction with the question of cost, necessitated a considerable alteration in the per acre quantities of manures applied this year as compared with the last. We have again taken poudrette as a basis, and the per acre application of it and of all other manures in comparison with it, each contains 500 lbs. of nitrogen. This quantity is much more than is taken up by a very heavy cane crop, but is less than that contained in a full dressing of poudrette or cattle dung as given by the cultivators of the district. On one plot of the comparative manure series we have applied a heavier dressing of poudrette equal to the heaviest application given by good cultivators. I think it may be accepted without any question that if an application of 500 lbs. of nitrogen per acre is found ample to produce a maximum crop, then the manures which are being tested must also contain sufficient of the other elements of nutrition. In any case the standard which has been adopted this year will be continued year by year until definite issues are obtained. Meantime it is certain that the varying proportions of potash, phosphoric acid, and organic matter in the manures used must have some influence on results. If this influence

The comparative manure experiment scheme considerably modified for reasons given.

The importance of noting the effects of elements other than nitrogen.

is fully or partially disclosed, the value of the experiments will be much enhanced.

Comparative manure experiments with bones, dissolved bones, and saltpetre, modified for reasons given.

17. Last year plots for bones, dissolved bones, bones + saltpetre, and dissolved bones + saltpetre were included in the comparative manure series, and compared with the other manures, taking the reputed percentage of nitrogen as a basis of comparison. It was known, of course, that the amount of phosphates necessarily applied with the nitrogen would be much in excess of what the crop could require. It was believed that bones, dissolved bones, and saltpetre contained higher percentages of nitrogen than they were found to contain, but we did not clearly anticipate that the cost of the dressings would be prohibitive and much beyond the means of ordinary cultivators. Saltpetre is dear in Poona, and it has already been explained that bones are rapidly rising in value in Bombay; and although the manufacture of weak sulphuric acid is now a local enterprize, making the local manufacture of dissolved bones possible at a cheaper rate than with imported acid, yet it is not expected that bones or dissolved bones, either alone or in combination with saltpetre, will prove economical manures for sugarcane in the Poona district. But the results of our tests may be useful to cultivators in other parts of India, especially in the North, where bones and crude saltpetre can be bought at moderate rates.

Bones or dissolved bones, either alone or with saltpetre, not expected to be economical manures in the Poona district.

Top dressing an economical practice.

18. Our last year's tests, I think, proved the fact that nitrogen in immediately available condition (as it exists in saltpetre) is the most important element of nutrition for sugarcane. This I will endeavour to show clearly further on. Saltpetre is exceedingly soluble, and as sugarcane is heavily irrigated, a good deal of the saltpetre would probably be lost by drainage, unless it is applied in repeated light dressings, and it is being so applied this year and will be so applied in future years. Last year's experiments tended to show also that it was advisable to apply manures which are much less soluble than saltpetre partly before plantation and partly as a top dressing, and for this reason we have decided to apply all manures, in the comparative manure series, three-fifths before plantation in February-March and two-fifths in June-July.

19. The complete scheme as now arranged, which I tabulate below, will be better understood from the above explanations.

A.—*Comparative Manure Series.*

	Manures applied for crop of 1895-96.	Quantity per Acre.	Percentage of Nitrogen.	Nitrogen per Acre.	Price of Manure per Ton.	Cost of manuring per Acre.	Remarks.
		Tons.		Lbs	Rs. a. p.	Rs. a. p.	
	Poudrette	44·6	1·007	1,000	6 12 0	301 0 0	Cost of manure includes application and cartage 10 miles.
	Do.	22·3	1·007	500	6 12 0	150 8 0	Do. do.
	*Cattle dung	25·1	0·89	500	6 6 0	160 0 0	Do. do.
	*Farm-yard manure ...	29·0	0·77	500	6 6 0	184 14 0	Do. do.
	Fish manure	2·9	7·60	500	65 1 7	188 12 0	Cost of manure includes application and freight from Thána, cartage 4 miles, and charge for reducing fish to powder under stone of chunam mill.
Manure cakes.	Castor cake	5·9	3·75	500	61 7 4	303 10 0	Cost includes cartage 8 miles, application, and charge for reducing cake to powder.
Manure cakes.	Karanj (Pongamia glabra) cake.	6·6	3·35	500	42 6 11	280 0 0	Do. do.
Manure cakes.	Mowra (Bassia latifolia) cake.	8·6	2·58	500	37 10 0	323 9 0	Cost includes application and freight (Rs. 10 per ton) from Bombay, powdering, and cartage 4 miles.
Edible cakes.	Cotton-seed cake	7·1	3·14	500	44 8 0	316 0 0	Do. do.
Edible cakes.	Safflower and groundnut cake.	3·4	6·50	500	47 10 0	162 0 0	Do. do.
Edible cakes.	Safflower cake	3·3	6·85	500	51 5 4	169 6 0	Cost includes application and cartage 8 miles and powdering.

*Cattle dung and farm-yard manure are much dearer in the neighbourhood of Poona than in out-districts. Where irrigated crops are largely grown in out-districts in the Deccan, the price is Rs. 2½ to Rs. 3 per ton. Indry crop tracts the price is not more than Rs. 1-8 per ton.

B.—*Comparative Manure Series.*

Manures applied for crop of 1893-96.	Quantity per Acre.	Nitrogen per Acre.	Phosphoric Acid per Acre.	Cost per Acre.	Remarks.
	Lbs.	Lbs.	Lbs.	Rs.	
Bone meal	3,520	130	750	116	The actual weight of dissolved bones will vary with strength of acid. This year the dissolved bones were manufactured on the farm. The acid was nearly pure, and 640 lbs. were used to dissolve 3,520 lbs. of bones.
Dissolved bones	3,520	130	750	196	
Bone meal and saltpetre ...	3,520 bone meal, 1,290 saltpetre.	130 / 120 } 250	750	116 / 148 } 264	Saltpetre applied ½ before plantation, ¼ in four top dressings at intervals of two months.
Dissolved bones and saltpetre.	3,520 bones dissolved, 1,290 saltpetre.	130 / 120 } 250	750	196 / 148 } 344	Do. do.

20. I tabulate below last year's results from comparative manure series. Each crop was irrigated twenty-eight times, and was harvested on an average 11½ months after plantation.

Comparative manure series results of the first year.

21. The crops were not equally ripe. Those which germinated well, and were dressed with quick-acting manures, ripened soonest; but it is impossible to decide definitely from the appearance of a cane crop when it is just ripe.

Crops not equally ripe when harvested for reasons given.

The Gul (crude sugar) owing to an overstocked market, and because we have no means of storage, was sold at an exceptionally cheap rate, viz., from Rs. 11 to Rs. 13 per *palla* of 240 lbs. Later in the season it usually rises to Rs. 15 to Rs. 18 per *palla*.

The Gul (crude sugar) very cheap this season.

The weight of juice is not entered because the cane was freely watered after it was prepared for the mill. This tends to prevent evaporation of the juice in the cane. If evaporation goes on, the juice in the cane becomes more concentrated and a greater percentage of sugar is left in the crushed cane.

The weight of juice not entered in tabulated statement for reasons given.

2nd Series. Comparative Manures. Plots ⅛ Acre each.

No. of Plot.	Kind of Manure.	Weight of manure per Acre.	Nitrogen per Acre.	Cost of manure per Acre.	Weight of cane stripped and topped per Acre.	Weight of tops per Acre.	Weight of Gul per Acre.	Per-centage of Gul to cane.	Value of Gul per Acre.	Remarks.
		Tons.	Lbs.	Rs. a. p.	Lbs.	Lbs.	Lbs.		Rs. a. p.	
4	Bone meal	5	420	244 11 0	56,710	11,640	6,945	12·2	358 0 0	Germination irregular and indifferent. Growth of crop slow at first. Subsequently growing probably to the solvent effect of irrigation on the bone meal, the growth was more rapid and the plants tillered freely. The outturn might have been considerably more if the crop had been cut a month later.
5	Dissolved bones ...	6	434	987 8 0	80,325	17,005	9,870	12·3	508 12 0	Manure obtained from a Calcutta firm, who manufacture chiefly for export. Freight charges added considerably to cost. The manure was believed to be more soluble. Analysis proved that only a small percentage of phosphates had been made soluble. Manure was applied in top dressings. This it was believed would be economical, because of the risk of the frequent waterings before germination washing it out of the soil. The results proved that part should have been given before plantation. The want of manure caused uneven germination. A top dressing to the young plants had an unmistakable effect in improving their colour and in causing them to tiller freely. Crop probably quite ripe when harvested. A salt efflorescence formed on the surface after each watering.

No. of Plot.	Kind of Manure.	Weight of manure per Acre.	Nitrogen per Acre.	Cost of manure per Acre.	Weight of cane stripped and topped per Acre.	Weight of tops per Acre.	Weight of Gul per Acre.	Percentage of Gul to cane.	Value of Gul per Acre.	Remarks.
		Tons.	Lbs.	Rs. a. p.	Lbs.	Lbs.	Lbs		Rs. a. p.	
6	Bones fermented with sugarcane ashes and cattle urine.	10	213	206 8 0	47,950	11,175	5,680	11·8	291½ 12 0	Manure applied partly before plantation, partly as a top dressing. The germination was uneven, and at no stage did the crop make satisfactory progress, nor did the plants tiller well. The manure was prepared in a pit, cattle urine being added daily to the refuse ash of sugarcane mixed with bones. Analysis has accounted for the nitrogen of the bones. The ashes could contain little, if any, nitrogen. The nitrogen of the urine, which must have been considerable, was lost. The urine during fermentation probably gave off carbonate of ammonia which escaped to the atmosphere. The ashes if they contained free lime would probably accelerate this loss. Anyway, it is clear that this method of fermenting bones causes a loss of nitrogen. The result might have been different if good loam had been used instead of ashes; but the object was to utilise as manure the refuse ash of sugarcane. It is the only residue left of an expensively manured crop, the crushed cane and dried leaves being used as fuel in boiling the juice. The results are considered conclusive, and this plot will be utilised to test the value of one of the edible oil cakes as manure in the revised scheme.
7	Fish manure	5	600	255 4 0	105,490	14,335	13,400	12·7	690 12 0	Cost includes freight charges from Thána and crushing the dried fish to powder under the stone of a chunam mill. Germination satisfactory. Plants tillered freely. Growth vigorous throughout. Crop quite ripe when harvested. The fish attracted crows, dogs, jackals, and pigs to the plot. The last did some harm by digging into the soil to get at the buried fish. An appreciable quantity of the manure was no doubt eaten. In the current season we took the precaution to bury the manure deeper by broadcasting it in the furrow behind the plough, the soil moved in making the next furrow covering it completely. The outturn is the best of the whole series, and considering the results, fish manure is undoubtedly cheap, though the nitrogen it contains costs considerably more than that in poudrette or cattle manure.
8	Castor cake	5	462	249 12 0	95,830	14,285	12,235	12·7	630 10 0	Cost includes powdering the cake and cartage 4 miles. Germination and tillering quite satisfactory. Crop made satisfactory progress throughout. Quite ripe when harvested.
9	Karanj (Pongamia glabra) cake.	5	441	248 2 0	87,695	15,305	10,640	12·1	548 7 0	The remarks made against Plot 8 apply to this plot also.
10	Bone meal and saltpetre.	{ 2·5 / 1·0 }	{ 210 / 207 } 417	423 14 0	86,950	13,980	9,975	11·4	514 2 0	The results proved that the saltpetre ought to have been applied in part before plantation. The germination was indifferent because bones alone do not supply the young seedlings with the ready food they need. The first top dressing of saltpetre showed its effect as soon as water was given. The plants within a day or two gained a much better colour and soon began to tiller freely. Half the saltpetre was applied early in April, half late in July. The crop was perhaps hardly ripe when harvested. The percentage of Gul to cane is less than in any other plot of the series.

No of Plot.	Kind of Manure	Weight of manure per Acre	Nitrogen per Acre	Cost of manure per Acre	Weight of cane stripped and topped per Acre	Weight of tops per Acre	Weight of Gul per Acre.	Per centage of Gul to cane	Value of Gul per Acre	Remarks
		Tons.	Lbs	Rs a p	Lbs	Lbs	Lbs		Rs a p.	
11	Dissolved bones and saltpetre	3 1	217 207 } 424	795 15 0	105 785	13 015	13,225	12 5	661 11 0	For reasons given in the remarks against Plot 5 none of the dissolved bones was applied before plantation The saltpetre was also applied in top dressings. Consequently germination was uneven The young seedlings began to thrive and tiller soon after the application of dissolved bones was given in March. The first top dressing of saltpetre in April had the effect of starting vigorous growth The second top dressing was given in July. The crop throve well during the whole period of growth and was quite ripe when harvested A salt efflorescence formed on the soil after each watering I have already explained that the cost of the manure is entirely prohibitive, necessitating a rearrangement of our scheme in respect of Plots 1 5 10, and 11 in the current season and in future years
12	Poudrette	42	847	280 12 0	103,175	13 975	13 270	12 8	684 0 0	Cost includes cartage 10 miles The crop germinated well and progressed satisfactorily afterwards and was quite ripe when harvested. Our results and chemical analysis indicate that the manure is a cheap if not the cheapest obtainable source of nitrogen in India, even at the Poona price, which is very high and in the agricultural interest of the country an extension of its manufacture or the utilization of night soil as manure in some other economical way is of the very greatest importance
13	Cattle dung from ordinary fed cattle	43	972	287 9 0	66,430	16 020	7,885	11 9	406 7 0	Cost includes cartage from the Poona Government farm (11 miles) The value of cattle dung as a manure for sugarcane must not be gauged by the results this year for reasons explained further on Germination irregular, and the crop never recovered the check at time of germination, due I believe, to the want of immediately available nitrogen for the young seedlings The outturn would probably have been more if the crop had been allowed to stand a month longer
14	Cake fed cattle manure preserved with urine and litter	42	798	283 8 0	50 510	11 790	6 115	12 1	315 3 0	The remarks made against Plot 13 apply with equal force here
15	Town sweepings ashes &c	54	Not determined	340 5 0	48 490	10 630	6 305	13 1	329 10 0	Cost includes cartage 10 miles. No estimation of nitrogen was made But as the manure consisted mostly of bulky material it could only have contained a small percentage Town sweepings ash varies so much in character that that applied in one part of a plot may differ considerably in composition and value from that applied in another, and outturn results must therefore be irregular This plot forms part of the comparative manure series but it also forms with Plots 16 & 17 a separate series to test the economy of ratooning cane and the effect of shade the same manure being applied to each of the three plots Irregular and poor results must be expected from town sweepings ash It was decided to manure these three plots in the current season and in future years with one of the edible oil cakes, which we are testing as manure. The percentage of Gul to cane is higher in this plot than in any other plot of the comparative manure series

22. In analysing the results recorded in the above table, I must in the first place direct attention to the differences in weight of nitrogen applied to different plots. The manures were applied, as already explained, before the samples were analysed, and in the absence of determination by analysis we applied quantities believed to contain 500 lbs. nitrogen more or less per acre. The percentages of nitrogen in cattle dung, farm-yard manure and poudrette were much under-estimated. The nitrogen in bones and dissolved bones was over-estimated. The estimate made in respect of saltpetre, castor cake, and Karanj cake would have been nearly correct if these manures were pure, which they were not.

Analysis of comparative manure series results.

We started our comparative manure series with an imperfect knowledge as to the composition of the manures employed, rather than lose a whole year. This is not to be regretted, because knowledge has been gained which necessarily must have been gained in the first year, which will be of very considerable value in the future.

Experience gained which will help the experiments in future years.

If the tabulated figures are closely studied, some of the results will be found so inconsistent that they appear almost inexplicable. They can, however, I think, be satisfactorily explained. The farm-yard manure and cattle dung results, for instance, compare very unfavourably with other results, the latter being obtained from manures which were decidedly poorer in the important elements of nutrition. The explanation is that the cattle dung and the farm-yard manure were applied before they were thoroughly decayed. The large stock of nitrogen which these manures contained was not therefore in immediately available form, and I am convinced that nitrogen in this form is by far the most important constituent of manures used for sugarcane. This conviction was forced by the appearance of the crop on the different plots at time of germination and afterwards. In my report of last year I noted that the sugarcane sets (pieces of cane about a foot long) evidently contained very little to nourish the young shoots, and unless the rootlets come at once in contact in the soil with nitrogen in immediately available form germination becomes uneven. A check in growth at this early stage is never afterwards recovered, nor do the plants tiller so freely as when the young shoots come up strong and vigorous.

An explanation of apparently inconsistent results.

Nitrogen in immediately available form an important constituent of manures for sugarcane.

23. The germination depends in a most remarkable manner upon the manure applied. In the current season as in last year's experiments the fish manure and poudrette plots are conspicuously ahead of the others in evenness of germination and vigour of growth. Both these manures have the reputation of acting very quickly in an irrigated soil, and doubtless do so. Last year we made the mistake of *not* applying any of the saltpetre *before* plantation, but entirely as a top dressing to the bones and dissolved bones plots, with the result that germination was indifferent. In the current season one-fifth of the saltpetre was given before plantation and the germination has been quite satisfactory. So also is the germination in the farm-yard and cattle dung plots, and this I attribute chiefly to the fact that these manures were kept over a year and were quite decomposed. It must of course be admitted that residues of manures in the soil left from the heavy dressing of last year may have some favourable influence on the satisfactory germination this year in the plots I have referred to, but judging from the appearance of all the plots, I am nearly certain that the chief influence is attributable to the manures directly applied.

Germination depends in a remarkable manner on the manure used.

The necessity of applying at least a light dressing of quick acting manure before plantation.

Bulky organic manures should be thoroughly decayed before use.

Samples of the soil of the field were taken before our experiments were started and analysed by Dr. Leather. It will be very easy therefore at any time to determine how much fertility any particular plot has acquired. This determination will be an important factor in fixing the relative values of the different manures used, because other conditions being equal, that manure which leaves the soil in the richest condition after several years' cropping must be considered best.

The relative values of manures will to some extent be gauged by the crop residues left in the soil of each plot after several years' cropping

Third Series.

24. *Object*—To test (1) how long cane can be ratooned profitably and (2) how far cane is injured by the shade of *Bábhul* and other trees. The latter test is being made on an irregular plot affected by the shade of hedge-row timber trees. Each plot was manured similarly and equally with Plot 15, and the results are comparable with those of that plot. As regards the results of the ratoon plot, the value of ratooning is in no way shown, the crop being grown from sets. The test really starts with the crop of the present season, which is a ratoon crop, *i. e.* grown from the stumps or root-stocks of the previous crop. The injury to cane from the shade or proximity to large trees is well shown; whilst the results on the ratoon crop, if compared with those of Plot 15, tend to show that town sweepings ash (a very heterogeneous mixture) gives irregular results. The results of the 3rd Series I tabulate below:—

Ratoon results begin with those from crop of present season.

Injury to cane by shade well shown by results.

3rd Series. Plots ⅛ Acre each.

No. of Plot.	Kind of Manure.	Weight of manure per Acre.	Cost of manure per Acre.	Weight of cane stripped and topped per Acre.	Weight of tops per Acre.	Weight of Gul per Acre.	Percentage of Gul to cane.	Value of Gul per Acre.	Remarks.
		Tons.	Rs. a. p.	lbs.	lbs.	lbs.		Rs. a. p.	
16	Ratoon plot (manured with townsweepings ash)	54	240 5 0	32,505	8,965	4,160	12·8	214 7 0	Germination very irregular. Crop made slow progress afterwards.
17	Shade plot (treated with the same manure)	54	240 5 0	25,497	8,720	2,874	11·2	148 2 0	Germination irregular and plants did not tiller much until the crop was half grown. Then a good many shoots came up which were half grown when the crop was harvested; hence probably the low percentage of Gul to cane.

Fourth Series.

25. *Object.*—To test whether a less quantity of water than that usually applied by local cultivators to sugarcane will or will not give equally good results. Plots to be irrigated every eighth day in the hot weather and every tenth day in the cold weather or during breaks in the monsoon rains. Ordinary cultivators get canal water once a fortnight in the hot weather, and this interval between waterings is believed to be too long.

26. The plots of this series are comparable with Plot 21 of the 5th Series which was similarly manured and was planted and harvested at the same time. The water taken for Plot 21 was not actually gauged, but it may be accepted that at each flooding approximately the same quantity of water was taken for this plot as for the "full supply plot," because in each case as much as the beds could hold was taken and the beds were made precisely of the same size in each plot. The cane was cut at eleven months and the crops were all apparently quite ripe. Plot 21 of the 5th Series was irrigated twenty-seven times or as often as the canal was opened for the cultivators' fields of the neighbourhood. Mr. LeQuesne, the Executive Engineer for Irrigation, had our water gauge fitted up and allowed us to take water for the plots of the 4th Series thirty-four times during eleven months. He also had a gauge fitted up in an adjoining cultivator's field. The cultivator irrigated his crop at night on several occasions, when there was no supervision at the water gauge. Averages are taken for these occasions, and I accept Mr. LeQuesne's figures as fairly accurate.

A narrative of the manner in which the comparative experiments were made in this series.

27. The results of the water experiment series are striking, and in my opinion prove in the most conclusive manner the importance of giving water to a cane crop often and in smaller quantity. Frequent watering in the hot weather is specially important. The outturn from each of the "water experiment plot" is considerably more than

Results prove in a striking manner the advantage of giving water to cane often and in small quantity specially in the hot weather.

that from any other plot in the whole area under experiment; and this must be attributed entirely to frequency of irrigation. The value of frequent irrigation in the hot season is made strikingly manifest in the sugarcane area under canal irrigation in the Poona district where a good cultivator owns a well. He gives water at least every eight days, but he gives no more than the crop needs, because he has the trouble of drawing it. On the other hand, if an average cultivator gets water *ad libitum* from the canal only once a fortnight, he takes as much as the beds will hold at each watering.

Cultivators who own wells irrigate cane lightly but often.

Cultivators who get canal water literally flood their fields.

28. In the interest of the Irrigation Department, I am compelled to admit that even if it was permitted to take water once in eight days, the average cultivator would take much more than is absolutely necessary, until such time as it is demonstrated to him that he is thereby spoiling his crop, and it might take years to satisfy his mind on this point. Meantime count must be taken of the extra loss of water by leakage (which is greatest in the hot weather) from the numerous distributing channels owing to the more frequent irrigation; and I can understand any Executive Engineer for Irrigation objecting to give water for irrigation in the hot weather oftener than is done at present. Under existing conditions the cultivator of sugarcane to a certain extent protects himself. He makes the beds for water compartments so deep that each time his crop is irrigated the field is literally flooded, in my opinion, to the detriment of the crop. There is no question that a good deal of this water is lost in drainage, and it is questionable whether this loss would not be more than counterbalanced by any extra leakage from the distributing channels caused by more frequent irrigation. In any case we cannot get away from the fact that our experiments tend to prove that frequent light irrigation, especially in the hot weather, increases the outturn very considerably. If it were practicable to introduce this system generally, the Irrigation Department as well as the cultivator would be benefited.

A plea for Irrigation Department's refusing to give water as often as the cane crop actually needs it.

The cultivator protects himself.

The Irrigation Department and the cultivators would be benefited if it were found practicable to introduce a system of frequent light irrigation.

29. I am quite convinced that one year's results on our experimental area are sufficient to prove this. Nevertheless the experiments are being continued. The results of the first year are tabulated below. The rainfall at Poona was 32·4 inches. Probably it was about 2 inches more at Mánjri, the ante-monsoon showers being there more frequent and heavy than at Poona.

First year's results believed conclusive but experiments continued

4th Series.

Comparative Water Experiments. Plots ⅛ Acre each.

No. of Plot	Method of Irrigation	Total quantity of water applied.	Equivalent inches of rainfall to water applied.	Cost of applying irrigation water per Acre.	Weight of canes stripped and topped per Acre.	Weight of tops per Acre.	Weight of Gul per Acre.	Per centage of Gul to Cane.	Value of Gul per Acre.	Remarks
		Tons.	Inches.	Rs. a. p	Lbs.	Lbs.	Lbs.		Rs. a p	
18	Watered each time with half the ordinary supply. Irrigated 34 times in 11 months	4,811·1	47 6	10 0 0	119,925	12,960	14,160	11 8	739 14 0	Cut 11 months after plantation. Plot manured with 42 tons poudrette per acre
19	Watered each time with three fourths ordinary supply. Irrigated 34 times in 11 months.	7,267·5	71 9	15 0 0	115,765	16,210	13,710	11·8	706 11 0	Do. do.
20	Watered each time with full ordinary supply Irrigated 34 times in 11 months	9,670 0	95·7	20 0 0	111,590	16,500	13,300	11·9	685 9 0	Do. do.
21	Watered each time with full ordinary supply and irrigated 27 times in 11 months.	7,679 (approximate.)	76·0 (approximate.)	9 0 0	106,000	14,705	11,920	11·2	614 7 0	The results of this plot are given in this table for comparison with the above 3 plots Cut 11 months after plantation. Plot manured with 42 tons poudrette per acre.
	Cultivator's field Water gauged by Mr LeQuesne. Field watered 26 times in 11½ months.	6,267	62							

Fifth Series.

30. *Object.*—To test at what period of growth sugarcane yields the highest percentage of sugar. Plots $\frac{1}{8}$ acre each and manured with 12 tons poudrette per acre.

A more difficult problem to solve than was anticipated for reasons given.

31. This apparently is a more difficult problem to solve than was anticipated. Cane is commonly called a 12-month crop. But judging from the appearance of the crops treated with different manures on our comparative manure series, I am persuaded that a quick-acting manure will force a cane crop to maturity in perhaps 11 months, whilst a crop treated with a slow-acting manure may take 12, 13, or more months to ripen. Again, I will have occasion in analysing the results of the 6th Series to point out that top-dressed crops were much greener at harvest time than those manured only before plantation. The former would obviously have continued to grow for some time; the latter were unquestionably dead ripe. It is clear I think that the period of growth at which cane contains the highest percentage of sugar cannot be determined off-hand. The question is of sufficient importance to warrant a more extensive scheme of experiments, and part of the additional area which will be acquired this year can be usefully employed for the purpose. The results of the first year are tabulated below :—

Necessary to extend this series of experiments in order to get definite results.

5th Series.

No. of Plot.	Special treatment of crop.	Weight of canes stripped and topped per Acre.	Weight of tops per Acre.	Weight of Gul per Acre.	Percentage of Gul to Cane.	Value of Gul per Acre.	Remarks.
		Lbs.	Lbs.	Lbs.	Lbs.	Rs. a. p.	
21	Cane cut and converted into Gul 11 months after plantation.	106,000	14,705	11,920	11·2	614 7 0	Crop irrigated 27 times. On this plot the former occupant of the field had a very large heap of poudrette, which when we took possession he carted away to other land. The site and surroundings of the poudrette heap were possibly manured more heavily than the remainder of this plot or the other plots with which it is comparable.
22	Cane cut and converted into Gul 11½ months after plantation.	95,250	16,110	10,965	11·5	565 3 0	Crop irrigated 28 times.
23	Cane cut and converted into Gul 12 months after plantation.	100,165	14,470	11,585	11·5	597 2 0	Crop irrigated 28 times; the last watering 3 weeks before harvest. The plot ought to have got one more watering. Canal water was obtainable the day before we began to harvest the crop.
24	Cane cut and converted into Gul 13 months after plantation.	105,785	12,120	12,475	11·8	643 0 0	Crop irrigated 30 times. The interval between the last watering and cutting the crop was longer than it ought to have been by four days.

No definite deductions to be drawn from results.

32. I do not think that any definite deductions can be drawn from the above figures. The 13-months crop gave the best outturn and contained the highest percentage of Gul to cane. The results are irregular. I can offer no explanation beyond the remarks made in the remarks column.

Sixth Series.

33. *Object.*—To test the effect of manure applied before plantation with the same quantity of manure applied at intervals partly before and partly during growth as a top dressing. I tabulate the results below :—

6th Series. Plots ⅛ Acre each.

No. of Plot.	Kind and quantity of manure and method of application.	Cost of applying manure per Acre.	Weight of canes stripped and topped per Acre.	Weight of tops per Acre.	Weight of Gul per Acre.	Percentage of Gul to Cane.	Value of Gul per Acre.	Remarks.
		Rs. a. p.	Lbs.	Lbs.	Lbs.		Rs. a. p.	
25	Farm-yard manure 42 tons per acre. All applied before plantation as is customary.	4 6 0	47,030	11,710	5,600	11·9	288 10 0	Germination irregular. Crop grew very slowly at first and never recovered the early check. The manure used was the same as in the comparative manure series (see remarks in tabulated results of that series). Crop harvested 12 months after plantation when quite ripe.
26	Farm-yard manure. Same quantity; one-third applied before plantation in February; one-third as a top-dressing in May; one-third as a top dressing in July.	16 14 0 includes cartage of quantity top dressed ½ mile.	51,090	11,270	5,940	11·6	306 3 0	Same remarks as above as to germination and slow growth at first. Late in the season the appearance of the crop indicated that it was making more progress than that of Plot 25. Cut 12 months after plantation. The leaves were quite green when the crop was harvested, an indication that if cut a month or so later the yield of Gul would have been more.
27	Poudrette 42 tons per acre. All applied before plantation.	3 12 0	96,465	13,255	11,475	11·7	591 8 0	Germination satisfactory and crop throve well throughout. Dead ripe to all appearance when harvested 12 months after plantation.
28	Poudrette. Same quantity; one-third applied before plantation in February; one-third as a top-dressing in May; one-third as a top-dressing in July.	15 1 0 includes cartage of quantity top-dressed, ½ mile	107,905	13,600	12,920	11·9	665 15 0	The crop made satisfactory progress throughout. Harvested 12 months after plantation, but the leaves were at the time quite green, an indication that the crop had not ceased to grow. The yield of Gul would probably have been more if the crop had been harvested later.
29	Castor cake 5 tons per acre. All applied before plantation.	2 8 0	79,465	12,445	10,095	12·7	520 5 0	This plot and the next with which it is comparable were damaged to some extent by flood water. The damage may have been greater in one plot than in the other. The results, I fear, are vitiated. Crop harvested 12 months after plantation and then quite ripe.

No. of Plot.	Kind and quantity of manure and method of application.	Cost of applying manure per Acre.	Weight of canes stripped and topped per Acre.	Weight of tops per Acre.	Weight of Gul per Acre.	Percentage of Gul to Cane.	Value of Gul per Acre.	Remarks.
		Rs. a. p.	Lbs.	Lbs.	Lbs.		Rs. a. p.	
30	Castor cake. Same quantity; one-third applied before plantation in February; one third as a top-dressing in May; one-third as a top-dressing in July.	6 9 0	88,525	13,500	10,145	11·4	522 15 0	See above remarks as to damage by flood water. The crop harvested 12 months after plantation and had then the appearance of being still growing. The yield of Gul would probably have been greater if the crop had been cut later.

34. In analysing the results of the 6th Series I leave out of account the castor cake plots, because the figures may be unreliable for comparison for reasons given in the remarks column of the above statement. The other results, particularly those of the poudrette plots, clearly indicate the advisability of applying manure to sugarcane partly before plantation and partly in repeated top-dressings. In the case of poudrette the results show a clear advantage, the outturn being increased in value to the extent of Rs. 74 per acre at a cost of about Rs. 11.

Results from castor cake plots unreliable.

The results from the poudrette plots clearly indicate the economy of applying part of that manure as a top-dressing.

35. The advantage of top-dressing a crop like sugarcane might almost be taken for granted without experiment, because if a very heavy application of manure is given before plantation, a good deal of the soluble ingredients must be lost in drainage. The crop makes slow progress at first, and it is at least two months planted before there is any appearance of vigorous growth, meantime it is watered oftener than at any season (once every four days' during the first fortnight), and the effect must be to wash the manure in part out of the soil.

The advantage of top-dressing might be taken for granted for reasons given, but it is necessary to prove its advantage by experiment, because the practice is unusual in the district.

36. The practice of top-dressing is unusual in the Poona district. The cultivator helps his crop in this manner only when an insufficient quantity of manure was given before plantation. It is therefore necessary to demonstrate, if possible, by experiment the advantage of top-dressing.

37. There was at least one result from this series besides those aimed at which though casual is none the less interesting and important. It was made clear from the appearance of the crops at harvest time that those manured entirely before plantation ripened sooner than those top-dressed. The latter were probably not quite ripe when harvested. It would have been of importance to have determined how much the yield of Gul would have increased by leaving the crop standing longer. This could have been done by leaving a portion of each top-dressed crop to be harvested when fully ripe. This would have, however, interfered with the experiments of the current year, and the point can be settled by separate investigation next year.

Casual results which may prove important.

38. The two new varieties of cane imported from Mauritius—one red and the other white—have not succeeded so well as I anticipated in my last report. The first year's canes contained a small percentage of sugar compared with the local variety (Pundia). These imported varieties were reported to be two of the very best varieties in cultivation in Mauritius, and they there yielded about 14 per cent sugar, whilst here the white variety gave 10·08 per cent. The red variety gave 9·4 per cent. The local (Pundia) variety grown in our experimental plots gave from 11·2 to 13·1, and in crop tests I have found it to contain often over 13 per cent. In other respects the new Mauritius cane did very well.

New importations of cane from Mauritius not wholly successful.

The canes grow as tall and as thick as the Pundia canes in our best plots, but the habit of growth is different from the local variety. The power of tillering is enormous, 20 to 30 fully grown canes from one stock is common. This year the whole produce has been re-planted excepting what was required for one boiling of each variety for Gul. The Gul of each variety was of good quality.

The Mauritius canes have a different habit of growth to the local variety.

Note by Dr. Leather on the Chemical Composition of Sugarcane and Sugarcane Juice and of the Raw Sugar obtained in the Experiments made at the Cawnpur and Poona Farms during 1894-95.

In the following note the results of a number of analyses of sugarcane juice and of the raw sugar are submitted, and in addition reference will be made to the several analyses of the whole cane.

The analyses obtained at these two farms are discussed in one note, with the object of comparing, as far as may be, the difference which occurred in the quality of the juice and of the Gur.

2. *The Juice.*—The amount of cane sugar was determined in a number of samples of juice from the cane immediately after pressing, at Cawnpur and at Poona, and the results are tabulated in Statement I.

STATEMENT I.

Percentage Cane Sugar in the Juice of Sugarcane.

Plot No.	Treatment.	Per cent Cane Sugar.	Plot No.	Treatment.	Per cent Cane Sugar.
	Cawnpur Cane Sugar Juice.			*Poona Cane Sugar Juice*—contd.	
1	No manure	14·46 13·63 8·57 (laid).	11	3 tons dissolved bones ... ... 1 ton saltpetre	17·19
2	7 tons cattle dung manure ...	10·51 17·56 15·57 15·63 (laid).	12	42 tons poudrette...	17·33 16·59
3	14 tons cattle manure	14·38 9·98 (laid) 9·29 (laid).	13	42 tons cattle dung	15·18 16·26
4	5 cwts. bone superphosphate ...	14·40 13·51 15·04	14	42 tons farm-yard manure ...	16·10
			15	55 tons sweepings	17·37
	Poona Cane Sugar Juice.		18	42 tons poudrette in all these plots. ½ normal water allowance ...	14·53 13·17 14·29
5	6 tons dissolved bones	15·96	19	½ do. do. ...	14·09 13·53 14·33
7	5 tons fish manure	16·32	21	Cane cut when 11 months old ...	12·37 13·13 14·51
8	5 tons castor cake ...	16·60 16·79	22	Do. 11¼ months old...	14·28 13·95
9	5 tons karanj cake	15·82 16·52	23	Do. 12 months old ...	14·11 15·11
10	2¼ tons bone meal ... ... 1 ton saltpetre	14·48	24	Do. 13 months old ...	14·41 17·01

As will be seen the percentage of sugar (parts of sugar per 100 parts of juice *by weight*) varied very much more at Cawnpur than at Poona. This is in all probability owing to the fact that at *Cawnpur* the crop was very much laid in all the plots by excessive rain.

Four samples of the juice of such cane were analysed, and, as will be seen, the percentage of sugar in three of them was considerably lower than that of the juice of the standing cane. The percentage of sugar in the juice of the standing cane ranged from somewhat under 14 per cent, up to as much as 17·5 per cent. The latter is an exceptional figure, and the percentage of sugar in the juice of the Cawnpur crop may be taken to have varied from 13·5 to 15·5 per cent. The percentage of cane sugar in the juice of the Poona sugar-cane crop was determined in a much larger number of samples, and in these there was very much greater uniformity than in the juice analysed at Cawnpur. The crop was in no case laid by rain to any extent, and these facts taken together lend a certain amount of support to the opinion expressed above that the juice of laid cane will contain a lower percentage of cane sugar than that of cane not so laid.

Looking over the percentages of sugar in the juice at Poona, it will be observed that a sharp distinction may be drawn between the juice of Plots 5 to 15 and that of Plots 18 to 24, that of the former series being considerably richer in sugar than that of the latter. The juice of the Plots 5—15 varied from 15·18 per cent to 17·33, whereas the juice from Plots 18—24 contained (with the exception of one sample) 12·87 to 15·11 per cent of sugar. It is not possible to say what the exact cause of this difference was. The description of cane was alike on all these plots as also was the method of planting. The Plots 18—24 were manured with about 42 tons poudrette. The manuring of the other series of plots varied in each case, but as Plot 12 was manured with the same amount of poudrette as the Plots 18—24, it might be anticipated that, if the manuring controlled the quality of the juice, the juice of Plot 12 would have contained a similar amount of sugar to that of Plots 18—24. This is, however, not the case. It may be further mentioned in reference to the possible effect of manuring that the amount of nitrogen applied in the manures to the Plots 18—24 and to the Plots 12—14 was about twice as much as was applied to the other plots, whilst the amount of phosphoric acid applied was less in the case of Plots 18—24 and 8, 9 and 12—14, than in the case of the other plots. It is evident therefore that the difference in the quality of the juice of these plots cannot be referred to the different methods of manuring or to the different amounts of nitrogen and of phosphoric acid applied in the manures.

The only explanation * which appears probable is that the lie of the land may have indirectly caused the difference. The land on which these plots are situated has a gentle slope, and the soil is a black open one, with soft rock (*murum*) within about two feet of the surface. The Plots 18—24 are all situated higher up on the slope than are those numbered 5—15; and bearing in mind the ease with which the irrigation water is known to travel through the subsoil, it must be admitted as possible that this drainage water has in some way assisted the cane on the lower-lying land to grow more concentrated juice than that on the plots adjacent but higher lying.

In any case the difference between the percentage of sugar in the juice of the one series of plots and in the other is very marked, and it will be of interest to observe whether a similar difference exists next year :—

STATEMENT II.

Samples of Gur from Cawnpur.

Description.	Cane Sugar.	Glucose.	Water.	Ash.
Cawnpur—Plot I	75·45	8·57	10 92	2·54
Do. „ I (laid)	67·82	...	...	...
Do. „ II	74·12	8·47	11·45	2·55
Do. „ III	74·61	9·06	12·17	2·69
Do. „ IV	75·31	8·76	12·59	1·94
Do. „ V	73·02	9·39	14·84	1·68
Do. „ VI	76·52	7·93	12·36	1·46
Do. „ VII	71·18	10·27	14·92	2·61
Do. „ VIII	71·88	8 47	14·87	2·18
Do. „ „ (laid)	63·78	14·39	14·02	4·76
Do. „ IX	70·04	10·89	13·77	3·26
Do. „ „ (laid)	64·51	13·54	14·79	2·69
Cawnpur "Dhaul"	79·45	7·13	5·61	3·16
Do. "Dickchan"	76·63	8·13	6·55	3·33
Do. "Baranka"	74·96	5·42	13·03	3·16
Do. "Saranti"	75·07	8·74	13·48	2·46
Partábgarh	70·35	8·82	7·05	3·89
Lucknow	69·64	10·15	11·95	3·23
Unao	72·28	9·88	10·09	3·03
Fyzabad	73·14	9·91	8·26	3·65

*A more feasible explanation I think is that the cane of Plots 18—24 was lodged or laid more or less, whilst the cane of Plots 5—15 was either not laid or laid to a very trifling extent.—J. MOLLISON.

STATEMENT III.

Sample of Gul from Poona.

Description.	Cane Sugar.	Glucose.	Water.	Ash.
Plot No. 4	76·41	10·92	9·85	1·40
„ „ 5	69·12	18·88	7·69	1 64
„ „ 6	75·93	10·43	9 84	1 52
„ „ 7	75·42	12·41	4·82	1·58
„ „ 8	77·65	9·88	9 77	1·44
„ „ 9	79·23	5 89	9·66	1·16
„ „ 10	74·73	10·66	10·27	1·58
„ „ 11	75·90	11·92	11·00	1·85
„ „ 12	75·56	12·25	9·86	1 33
„ „ 13	77·20	11·41	10·26	1 52
„ „ 14	77·40	11 85	7·18	1 33
„ „ 15	77·38	10·86	8·97	1 37
„ „ 18	74·71	15·71	10·44	1·40
„ „ 19	71 99	14·45	10·56	1·20
„ „ 20	75·23	13·77	9·58	1·45
„ „ 21	73·19	13·90	11·35	1·36
„ „ 22	75·85	12·56	8·57	1·28
„ „ 24	76·68	11·41	9·85	1·40

8. *The Raw Sugar* (*"Gur" or "Gul"*).—The Statements II. and III. exhibit the analyses of samples of raw sugar from Cawnpur and Poona farms. in addition it was thought desirable to analyse some of the Gur prepared by cultivators. They are all samples selected from the North-West Provinces districts. Samples of cultivators' Gul prepared near Poona were not analysed this year, the amount of work having become already too great to admit of it at present.

In the case of the raw sugar it was possible to determine not only the amount of cane sugar but also that of the "glucose" or uncrystallisable sugar, the water, and the mineral matters. These have been determined in all the samples. In addition to these items, there has been determined in several of the samples the amount of nitrogen, the solid substances such as bits of cane and sand, and the phosphoric acid.

Considering now the analyses of the samples of Gur prepared at the Cawnpur farm we find that the Gur of Plots I.—IX. (excluding for the present those relating to laid cane) contained from 70 to 76·5 per cent of cane sugar, from 7·9 to 10·9 per cent of glucose, from 10·9 to 14·9 per cent of water, and from 1·46 to 3·26 per cent of mineral matter.

In the case of Plots I., VIII. and IX., samples of the Gur from the laid cane were separately analysed, and as will be seen, the percentage of cane sugar was much lower and the glucose much higher than in the Gur from standing cane. There is thus a coincidence between the quality of the juice from laid cane and that of the Gur obtained, and this year's analyses would therefore indicate that *at least for this variety* of cane, the "Matna," it is important to prevent it from being laid by heavy rain and wind.

The figures in the second division of the statement relate to the Gur of four varieties of cane grown on land adjacent to the Plots I.—IX., but which was more subject to water-logging than that of Plots I.—IX. Indeed this cane was so much damaged that the weight of the sugar obtained is, I believe, acknowledged to be far below what it ought to have been. If to this fact be added the evidence obtained by the analyses of the juice and Gur of some of the other (Matna) cane, it is not a little surprising to find that the percentage of cane sugar is higher and the percentage of glucose and water generally lower than in the Gur of the adjacent crop of Matna cane (Plots I.—IX.). The proportion of mineral matters is distinctly higher. No analyses of the juice of these four varieties of cane were made, and it is not possible to say what its quality was; but if, with distinctly poor crops, these varieties produce a better sugar, it might be naturally expected that if the crops were really good ones, some of these

varieties of cane would be more profitable to grow than the Matna. Another year's results may throw light on the point. The high percentage of ash is the worst feature in their composition.

In the third division of Statement II. are exhibited the analyses of several samples of Gur prepared by cultivators in the districts named in the first column. They are on the whole of about equal quality to that prepared on the farm. Their worst feature was the amount of dirt, bits of cane and earth, which they contained. This is of course readily understood, when it is borne in mind that the juice at the farm was all passed through a cloth before being boiled down, and this of course the cultivators can readily do, so soon as there arises any call for it in the bazár.

In Statement III. are exhibited the analyses of the various samples of raw sugar (Gul) selected from that prepared in the Poona experiments. The percentage of cane sugar varies from 69·1 to 79·2, and in the majority of samples it was higher than that prepared at Cawnpur. The glucose, however, with one exception, was distinctly higher than in the Cawnpur samples. It varies from 9·88 to 18·88 per cent, one sample however containing only 5·89 per cent. The moisture, with the exception of one sample which contained only 4·8 per cent, varied from 7·1 to 11·35 per cent, and was generally less than what the Cawnpur Gur contained.

The proportion of mineral matters varied from 1·16 to 1·85, which is distinctly less than that in the Cawnpur Gur.

It may be well in concluding this paragraph to refer briefly to one or two points in connection with the quality of the Cawnpur farm Gur and the Poona Gul. Both these names apply to the raw sugar obtained by boiling down the juice until it will solidify on cooling.

Doubtless it is, from the cultivator's point of view, the most important thing to produce as great a weight of sugar as possible, irrespective of any niceties of composition, and judging by the analyses of the five samples of Gur exhibited in the third division of Statement II., it would appear that for ordinary bazár purposes their Gur is just as good as that produced at the two farms. When therefore we find that from three to four times as much raw sugar per acre is produced at Poona as at Cawnpur, it will be evident that this result must, at present at any rate, bear a value very much above that of the composition of the Gul.

It is however to be noted that in the neighbourhood of both these farms refined sugar is being made on a large scale, and it will not be out of place if, whilst determining the variety of cane and the mode of growing it, which will produce the most raw sugar, we bear in mind that there will probably be a demand for raw sugar for *refinery* purposes. It is for this reason that I draw attention in the next place to the amounts of glucose and mineral matters in the raw sugars which have been produced at the farms. The percentage of cane sugar was much about the same in the two sets of samples. But the proportion of glucose is distinctly less in the Cawnpur samples than in those from Poona. It may be that this is to be referred to some inherent quality of the juice of the cane; but I think it may in part be owing to the fact that at Cawnpur a mixture of potash and a mucilaginous substance was added to the juice, in order on the one hand to neutralize the acidity of the juice and thus prevent to a greater or less degree the "inversion" (*i. e.* glucose formation) of a part of the cane sugar, and on the other hand to cause a precipitation of the albumenoids of the juice, and the analyses would indicate that the alkali has really had the above indicated effect to a certain extent.

This is a point which will be worth while experimenting with another year. I am inclined to think that potash is not the most suitable alkali to employ, and it may prove better to add some caustic lime or carbonate of lime instead. The other point to be noted is the distinctly higher percentage of mineral matter in the Cawnpur Gur than in that made at Poona. Possibly the higher proportion at Cawnpur is to be referred in part to the addition of potash to the juice (as above mentioned), but that it is important for refinery purposes to keep the proportion of mineral matter low will be appreciated when it is mentioned that

refiners consider that one part of soluble mineral matter will prevent five parts of crystallisable sugar from crystallising. All the mineral matter in the raw sugar is not soluble, and the amount of soluble mineral matter was determined in only three samples, in which it amounted to 2·06, 3·79, and 2·59 per cent respectively.

It may be of value however to bear the point in mind.

4. *The total Sugar in the Cane.*—When the cane is crushed in an ordinary mill such as those employed by the cultivators, only a portion of the juice, and consequently of the sugar also, is extracted. A certain portion remains behind and is lost. An attempt was made to determine the amount of this in two ways. The one was by determining the amount of sugar left in the refuse crushed cane, the other by determining the total amount of sugar in the cane. The results of neither method were however satisfactory. Difficulties, which need not be here entered upon, were met with, and it must be left to a future occasion to perfect the methods employed and thus arrive at the result.

An approximate estimate has been made by an indirect method, the net result of which goes to show that at Poona from 2 to 2·5 per cent of sugar was thus lost, whilst at Cawnpur the loss was not less than 5 per cent. The latter amount is certainly very large, amounting to fully $\frac{2}{5}$ of the total sugar in the cane. The cause of this must not be hastily put down to the mills employed. On the contrary, the results obtained with the Pundia cane, some of which was crushed by Mr. Sabbiah at the Cawnpur farm, show a very different result. In the case of the Matna cane, which was the main crop in the Cawnpur experiments, only 50 per cent of juice was extracted, whilst no less than 69 per cent of juice was obtained from the Pundia cane with a corresponding proportion of Gur, and although no analyses were made of the Pundia cane or its juice, there cannot have been more than 2 per cent of sugar left in the refuse, and it was probably much less. The amount of Gur obtained was far higher than any grown at the farm, and the proportion of Gur, namely, 13·7 from 100 parts of cane, was distinctly high. The Pundia Gur gave the following results—

Cane Sugar.	Glucose.	Ash.
75·78	11·18	1·82

showing it to be a good sample of raw sugar. It would appear therefore that the high proportion of sugar *not extracted* at Cawnpur was more likely occasioned by the quality as hardness of the cane itself, and if this should prove to be the case, it will show the desirability of growing a cane from which a high proportion of the juice may be extracted.

5. The amount of phosphoric acid and nitrogen in the sugarcane crop.

The sugarcane crop is generally supposed to be a very exhausting crop, and it is therefore of interest to determine as accurately as possible the amount of nitrogen and phosphoric acid, lime and potash, which it takes from the soil. An attempt was made to determine the nitrogen and phosphoric acid, but in this case, as in the determination of the total sugar, difficulties were experienced consisting chiefly in getting what were really representative samples of the materials, and a further endeavour to overcome the difficulties and make more exact determinations will be undertaken next year.

So far, however, as one can judge by such analyses as have been made, the amounts of nitrogen and phosphoric acid in the crops at the two farms respectively are as follows:—

Assuming 40,000 lbs. of cane and 4,000 lbs. of tops per acre to represent the Cawnpur crop, the total amount of phosphoric acid was about 24 lbs. and the nitrogen 34 lbs. per acre. And assuming in the case of the Poona crop 100,000 lbs. of cane and 14,000 lbs. of tops per acre, the total amount of phosphoric acid was about 50 lbs. and the nitrogen about 94 lbs. per acre.

A wheat crop of 600 lbs. of grain per acre will remove (including the straw) about 6 lbs. of phosphoric acid and about 13 lbs. of nitrogen per acre.

APPENDIX II.

Balance Sheet of the Poona Farm, 1894-95.

Receipts.	Rs. a. p.	Amount. Rs. a. p.	Expenditure.	Rs. a. p.	Amount. Rs. a. p.
To sale proceeds of farm produce, 1894-95—			By rent of land	.....	122 0 0
Grain	105 15 0		Assistant Superintendent's pay	.....	902 11 10
Fodder crops	1,989 8 6		Establishment pay	.....	588 0 0
Potatoes...	961 0 7		Horse allowance	.....	240 0 0
Gul	13 9 0		Travelling allowance...	.....	127 10 0
Ginger	14 14 9				
Vegetables	140 10 2		By ordinary expenditure—		
Manures	72 13 6		Labour and cost of up-keep of farm bullocks...	1,872 3 4	
Fruits	12 8 0		Skilled labour	25 6 6	
Live stock	44 0 0		Purchase of manures	329 5 3	
Miscellaneous receipts	76 10 6		Do. seeds for sowing	274 8 4	
To value of farm produce of 1894-95 unsold on 31st March 1895—		3,480 10 0	Do. dead-stock and furniture ...	175 10 0	
A. Since sold :—Grain	0 6 8		Do. stationery, service stamps, and telegram charges ...	59 12 6	
Potatoes	6 13 4				
Fodders	68 4 8		Miscellaneous	143 2 1	
Vegetables	0 15 0		Irrigation charges	163 3 0	
		76 7 8	Petty improvements	23 0 0	
B. On hand—Fruits	45 0 0				3,066 3 0
Grain	170 6 10				
Jowári and Vál fodder growing and nearly ripe	95 0 8				
Onions	50 0 0				
Turmeric	21 2 6				
Potatoes	85 0 0				
Cotton	4 0 0				
Guinea-grass—Value of growing crop and established plantation	225 0 0				
		695 10 0			
To net increase of dead-stock	73 0 6				
Do. live-stock	159 0 0				
		232 0 6			
Total ..	.....	4,434 12 2			
To Net Cost ...	.....	611 12 8			
Total ...	.....	5,046 8 10	Total ...	.....	5,046 8 10

APPENDIX III.

Dairy Balance Sheet for the year 1894-95.

Income and Increase in Value of Stock.	Rs. a. p.	Amount. Rs a. p.	Expenditure.	Rs. a. p.	Amount Rs a. p.
To sale of milk and butter, the produce of farm cattle ...	15,302 15 5		By Overseer's pay		180 0 0
			„ Herder's pay		204 0 0
„ sale of milk tins and jars	23 9 0		„ Concentrated food bought ..	5,577 4 4	
„ sale of live stock	620 11 6		„ Fodder bought	4,013 11 0	
			„ Rent of grass land	854 8 0	
„ water-pipe charges recovered	6 0 0		„ Hay-making exponses	523 0 1	10,968 7 5
		15,952 3 11			
„ butter on hand on 31st March 1895 ..	42 0 0		„ Labour	2,515 11 3	
			„ Water-rate	36 0 0	
„ value of hay in stock ...	1,507 9 2		„ Cost of repairs and incidental outlays for management of dairy and dairy herd	1,698 1 4	
		1,549 9 2			4,249 12 7
„ increase in value of live stock		1,109 0 0	„ Purchase of dairy utensils, &c. ...	207 12 6	
			„ „ of live stock	2,232 10 0	
					2,440 6 6
			„ Expenses incurred in connection with outbreak of rinderpest among the dairy herd (purchase of fuel for burning carcasses, medicines, &c.) ...	.....	266 7 1
			„ Butter on hand on 31st March 1894, but disposed of during the year ...	.....	35 0 0
			Total ...	..	18,344 1 7
			By Net Profit ...	...	266 11 6
Total		18,610 13 1	Total	...	18,610 13 1

APPENDIX IV.

Valuation Statement.

Description.	Stock on hand on 31st March 1894. Number.	Amount.	Stock on hand on 31st March 1895. Number	Amount	Increase.	Decrease.	Remarks.
		Rs. a p.		Rs. a. p.	Rs. a. p.	Rs. a. p	
Working bullocks	6	320 0 0	4	185 0 0	...	135 0 0	
	6	320 0 0	4	185 0 0	..	135 0 0	
Dead Stock—							
Farm implements ...	...	1,881 6 0		1,912 2 6	30 12 6	...	
Office furniture	...	64 12 0	..	107 0 0	42 4 0	.. ..	
		1,946 2 0		2,019 2 6	73 0 6	..	

APPENDIX V.

Dairy Herd.

Description.	Strength on 1st of April 1894.	Increase.			Decrease.				Strength on 31st March 1895.	Valuation.		Increase or decrease during 1894-95.
		Purchased and transferred.	Born.	Total.	Sold	Died.	Transferred.	Total.		1894.	1895	
Cows.										Rs.	Rs.	
Stud Bulls	3	2	...	2		1	..	1	4	160	260	+ 100
Cows	32	11	...	11	5	12	...	17	26	2,061	1,770	- 291
Heifers	7	1	...	1	1	...	4	5	3	220	120	- 100
Cow Calves	19	2	17	19	2	8		10	28	275	575	+ 300
Bull Calves	21	...	13	13	9	10	..	19	15	265	375	+ 110
Total ...	82	16	30	46	17	31	4	52	76	2,981	3,090	+ 109
Buffaloes.												
Bull Buffaloes	...	1	...	1	...	...	...	...	1	...	120	+ 120
She Buffaloes	36	11	...	11	1	2	...	3	44	2,940	3,550	+ 610
Heifers	11		...	...	...	...	2	2	9	240	285	+ 45
She Buffalo Calves	20	...	15	15	4	6	..	10	25	190	375	+ 185
Bull do. ..	19		20	20	16	15	...	31	8	120	110	- 10
Total	86	12	35	47	21	23	2	46	87	3,490	4,440	+ 950
Dairy Cart-horses	2	1	...	1	1	...	...	1	2	100	150	+ 50
												+ 1,109

APPENDIX VI.

The Sheep Flock.

Description.	Strength on 1st of April 1894.	Increase.			Decrease				Strength on 1st of April 1895.	Valuation.		Increase or decrease during 1894-95.
		Purchased and transferred.	Born	Total.	Sold.	Died.	Transferred.	Total		1894.	1895	
										Rs.	Rs.	Rs.
Breeding Rams ...	1	1	...	1	...	...	...	...	2	31	60	+ 29
Ewes	19	23	...	23	...	3	...	3	39	57	260	+ 203
Female Lambs ...	12	6	6	12	..	1	8	9	15	18	40	+ 22
Male Lambs	5	...	11	11	4	1	...	5	11	10	50	+ 40
Total ...	37	30	17	47	4	5	8	17	67	116	410	+ 294